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ENGINEERED OPERATING CYCLE PROGRAM DEVELOPMENT MANUAL

August 1978

Prepared for
SHIP SUPPORT IMPROVEMENT PROJECT
NAVAL SEA SYSTEMS COMMAND
Washington, D.C.

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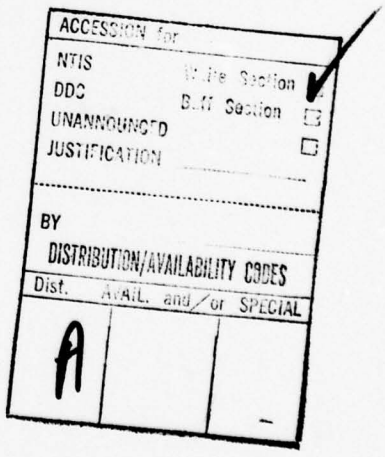
ABSTRACT

An Engineered Operating Cycle (EOC) program involves the engineering of maintenance requirements and procedures to improve and then maintain the material condition of selected ship classes while maintaining or increasing their operational availability. This document presents guidelines for the development of an integrated EOC program. It is designed to serve as a reference for EOC program managers during the three phases of the program: Initiation, Development, and Implementation. Included in this manual are process diagrams, a master program network, a plan of action and milestones (POA&M), and accompanying narratives describing in detail the events and documents required to initiate, develop, and implement an EOC program.



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CHAPTER ONE

INTRODUCTION TO EOC PROGRAMS

1.1 OBJECTIVE

An Engineered Operating Cycle (EOC) program involves the engineering of maintenance requirements and procedures to improve and then maintain the material condition of selected ship classes while maintaining or increasing their operational availability. This manual has been developed to facilitate greater understanding and effectiveness by those tasked to initiate, develop, and implement new EOC programs.

The guidance presented herein has been developed from experience in previous EOC programs and should prove beneficial in the initiation of new EOC programs. This manual includes the basic elements of those precedent programs and offers pertinent organizational and planning information that will materially assist new EOC programs.

1.2 DEVELOPMENT MANUAL ORGANIZATION

This manual describes the EOC concept and the associated planning process in increasing levels of detail. It relates the development of the Engineered Operating Cycle approach and its relationship to other maintenance programs. It presents guidelines for selecting and planning a ship EOC, with detailed sections for each phase of an EOC program and one dealing with EOC Program Management.

Additionally, appendixes are provided on the topics of existing EOC programs; comparison of current and alternative maintenance strategies for surface ships; program data needs; Program Functions, Assignments and Responsibilities (FAR) Matrices; a suggested EOC Plan of Action and Milestones; and selected program analysis procedures.

Finally, pertinent definitions, abbreviations, and acronyms have been compiled, and a bibliography is included.

1.3 HISTORICAL DEVELOPMENT OF EOC PROGRAMS

In 1973, the Chief of Naval Operations (CNO) determined that various ship material inspections and reports indicated that, despite increasing maintenance costs, the Navy's surface ships were generally in unsatisfactory material condition.

The CNO therefore tasked the Commander, Naval Sea Systems Command (NAVSEA), to (1) investigate the feasibility of adopting extended overhaul cycles for destroyer-type ships, (2) investigate the feasibility of adapting a submarine-type Integrated Maintenance and Modernization Planning (IMMP) Program to destroyer-type ships, and (3) compare the projected annualized costs of these maintenance policies with current annualized costs of maintenance for the same types of ships.

On the basis of the study results, NAVSEA concluded that (1) extending the overhaul cycles for certain classes of destroyer-type ships was feasible, (2) some small economy in total cycle maintenance costs could be anticipated as a result, and (3) additional management resources would be required to develop and manage a long-range maintenance management plan made necessary by the overhaul-cycle extension. That long-range plan would serve as a guide for scheduling and controlling major maintenance work, provide the capability for continuous review and evaluation of the material condition of the ships under the program, and provide the requisite assessment of individual ship material condition.

A number of maintenance-related programs were then in process, including:

- Pre-Overhaul Tests and Inspections (POT&I)
- Ship Alteration and Repair Package (SARP)
- Ship's Force Overhaul Management Systems (SFOMS)
- Extended Overhaul Cycle (EOC)
- DD Integrated Maintenance and Modernization Program (IMMP)
- 1200-psi Standards for Overhaul Program
- Maintenance and Material Management System (3-M/PMS/CSMP/PMDO)
- General Overhaul Specification Development
- Machinery Vibration Monitoring in FF/CV/SSBN Types
- Propulsion Examining Board (PEB)
- Navy Enlisted Occupation Classification System (NEOCS) Study
- Type Commander Boiler Inspection Teams
- Machinery Condition Analysis R&D
- Total Ship Test Program (TSTP)
- Ship Assistance Teams (SAT) for various special systems

Despite the improvements the other programs promised, in 1974 CNO directed that the Destroyer Engineered Operating Cycle (DDEOC) program be developed to upgrade the material condition of certain destroyer type ships. Those programs have continued to aid the fleet, and the DDEOC program has included the necessary planning and management considerations to derive full benefit from their use.

Current planning indicates that a majority of the Navy's ships will be in an EOC by 1984. See Appendix A for a complete description of existing EOC programs.

As these maintenance-related programs concurrently evolved, CNO Project Red "E", now PMS 306 - Ship Support Improvement Project (SSIP), was created in January 1975 to draw together, coordinate, and integrate all maintenance-related programs for surface ships. PMS 306 was tasked to initiate a project for the development and engineering to implement an integrated ship maintenance strategy. The goal of the project was to maintain ships in a state of material readiness for war, at the lowest peacetime cost commensurate with war readiness requirements. Execution of the project involved two parallel efforts:

- Conduct a major unconstrained analysis of alternative surface ship maintenance strategies
- Plan and develop an improved integrated maintenance strategy based on analysis, experienced judgment, and observation of the most successful elements of all Navy surface, submarine, and aviation maintenance programs

The SSIP has initiated some surface ship EOC programs and planned and scheduled others for initiation. This manual was developed for the project to facilitate the initiation of any additional EOC programs.

1.4 CURRENT STATUS OF EOC PROGRAMS

Although there are numerous EOC programs scheduled and in various stages of development and implementation, they all have common goals and similar support and interface requirements. These similarities and commonalities should be used to advantage by making use of established support organizations, plans, techniques, etc., in establishing new EOC programs.

1.4.1 EOC Program Definition

An EOC program establishes a structured engineered approach for maintaining ships of a given class. It defines a maintenance strategy to achieve maximum reliability of the ships and maintain or increase operational availability at an acceptable cost. It anticipates maintenance and modernization requirements for each echelon of maintenance support and plans for required resources at the appropriate point in the operating cycle.

1.4.2 EOC Program Objectives

The objectives of all EOC programs are basically those of the original CNO Objective No. 3, which highlighted the ship material condition problems and initiated actions to resolve them. The EOC program is designed to effect an early improvement in the material condition of designated ships, then maintain their combat readiness at an acceptable cost while maintaining or increasing their peacetime operational availability.

1.4.3 EOC Program Interrelationships

The high degree of commonality and similarity between EOC programs offers substantial benefits from the use of established products, procedures, organizations, etc., in use by other EOC programs. The primary benefits fall into two categories - program effectiveness and program resources.

EOC program effectiveness can be enhanced through the use of existing plans, procedures, and techniques that have been proven effective in other EOC programs. The experience of other EOC programs should always be reviewed to determine the extent of commonality between the existing and the proposed programs in the objectives and constraints; the ships, their missions, their systems, and their equipment; and the amount, form, and content of data available, and the associated analyses performed. In addition, the existing EOC program products, studies, plans, procedures, and their associated effectiveness should be reviewed. The greater the commonality, the greater the potential benefits.

Effectiveness is not the only benefit to be derived. There is also the benefit of savings from taking advantage of existing EOC program experiences. Avoiding duplication of analytical and engineering development work offers substantial savings in men, money, and especially time.

In addition to the benefits derived from commonalities in the analytical and engineering aspects of an EOC program, substantial benefits are available from the use of common support facilities and organizations, such as Technical Groups and Type Commander (TYCOM) Site Teams. It is obviously more efficient to add an additional program to a functioning organization instead of training and staffing an entirely new activity.

1.4.4 Relationships with Other Maintenance Programs

Just as benefits are available from the commonalities and similarities between EOC programs, benefits are also available from commonalities and similarities of separate but interrelated maintenance programs. Several maintenance programs have been established in the past to solve particular operational or maintenance problems, improve material condition, or increase operational availability. In this respect they are related to EOC programs. Therefore, EOC programs should take advantage of the experience acquired

and the effective results produced over the years by these programs. The efforts should be coordinated to a common goal, thereby minimizing conflicts in requirements, procedures, funding, etc. Some of the programs that are related and with which coordination is required are:

- 1200-PSI Propulsion Plant Improvement Program - This program has been developed to address the preparation, execution, and evaluation of tests necessary to demonstrate the operational reliability and readiness of the propulsion plant.
- Gun Weapon System Replacement Program (GWSRP) - This program has been designed to establish policy and procedures for developing requirements planning data, defining areas of funding responsibilities, and implementing the replacement of gun weapon systems.
- Rotatable Pools - This supply support program utilizes Fleet Intensified Repairables Management (FIRM) concepts to make available piece parts, modules, and repairable components to permit quick-turnaround ship maintenance during short availability periods.
- Shore Intermediate Maintenance Program - This program has been designed to provide adequate capabilities and capacities for intermediate level maintenance and increase productivity through the modernization and improvement of six existing surface Fleet Maintenance Assistance Groups (FMAG).
- Afloat Intermediate Maintenance Activity Improvement Program - This program was established to upgrade the installed industrial facilities in designated destroyer tenders (AD), repair ships (AR), and submarine tenders (AS), to ensure their capability to meet fleet demands of the 1980's for afloat Intermediate Maintenance Activity (IMA) support.
- Shop Qualification Improvement Program - This program has been designed to develop shop procedures and manuals, and implement an on-the-job training program to upgrade the fleet's intermediate maintenance capabilities through improvement in job procedures, industrial repair skills, shop management, and quality assurance.
- 3-M (Maintenance and Material Management) System - This program is significant to an EOC program because it provides in its Maintenance Data System (MDS) the best vehicle for collecting historical or program effectiveness maintenance data.
- Reliability Centered Maintenance (RCM) - RCM is a methodology to develop scheduled maintenance requirements by utilizing a systematic, logical approval of evaluating the failure modes of equipment and their consequences. The resultant scheduled maintenance are tasks that prevent specific failures or tests which assure confidence that essential off-line or non-observed functions are available. Upon its completed development, RCM methodology will be used in the development of maintenance strategies for EOC ship classes.

Additionally, the effects of maintenance planning and support are included in the second 3-M subsystem, the Planned Maintenance System (PMS).

CHAPTER TWO

EOC PROGRAM DEVELOPMENT MANUAL OVERVIEW

2.1 INTRODUCTION

This chapter provides an overview of the objectives, use, and structure of the EOC Development Manual. The purpose of the Manual is to guide those tasked to initiate, develop, and implement new EOC programs. It is a product of experience in preceding EOC and other maintenance management programs and is designed to promote development of cost effective, implementable EOC programs that are not duplicative nor in conflict with existing programs. The manual will provide guidelines to ensure that the EOC program contributes to an improved material condition for the classes of ships involved during their operating cycles.

2.2 OBJECTIVES OF THIS MANUAL

The Ship Support Improvement Project, which sponsors and coordinates a number of EOC programs, recognized the need for a manual to assist in the development of new EOC programs in order to capitalize on lessons learned from previous ones, to save costs by avoiding duplication, and, where feasible, to standardize programs. Under those guidelines this EOC Development Manual has been written.

This EOC Program Development Manual attempts to expedite the process of initiating EOC programs by:

- Providing written guidance that will offer a step-by-step standardized method for initiating EOC programs. The guidance is intended to meet the following objectives:
  - Identify EOC program planning requirements that must be considered, such as definition of objectives, feasibility study, resource estimate, schedule alternatives, data management, and administrative procedures.

- Provide guidance for the accomplishment of each of the three phases of an EOC program: Initiation Phase, Development Phase, and Implementation Phase.
- Identify EOC program engineering requirements that must be considered, such as trade-off studies, critical equipment and system analyses, commonality studies, equipment maintenance engineering analyses, class and ship maintenance plans, ship class material condition baseline, and ship material condition monitoring and assessment.
- Provide guidance to allow the program to remain as unconstrained as possible until significant engineering analyses have been completed during the Development Phase. Constraints to be defined during the analyses might include operating cycle length, maintenance strategy, costs, overhaul requirements, and similar factors.

- Developing a documented set of guidelines to direct the development and implementation of the engineering aspects of EOC programs.
- Clarifying the relationships of various Naval activities concerned with EOC programs such as the offices of the Chief of Naval Operations, the Naval Sea Systems Command Headquarters, and the Planning and Engineering for Repairs and Alteration (PERA) organizations, and specifying how these offices will assist in the fulfillment of the various EOC program requirements.

2.3 DEVELOPMENT MANUAL USE

The EOC Program Development Manual is designed for use by different organizations and by different levels within those organizations. For those seeking a broad general knowledge of EOC programs, Chapters One and Two provide overviews and general information. For those seeking more details regarding the development process, Chapters Three, Four, and Five provide detailed descriptions of the process for each phase of the program, and Chapter Six provides a management overview. The manual is designed so that the individual diagrams outlining the steps of each phase can be folded out for reference while the narrative is being read.

For those involved in the detailed development or management of EOC programs, the manual may be used for scoping and scheduling, i.e., for identifying for each phase of a particular EOC program the procedures to be specified, the analyses to be performed, and the documents to be prepared. Not all requirements are necessarily applicable, and not all are necessarily applicable to the same degree.

The recommended procedure for using the Development Manual as a scoping tool is for the user to consider each EOC program phase in light of the expressed or implied EOC program objectives and constraints, noting the

extent to which each specified procedure, analysis, or document applies. A major factor to consider is the availability of the required types of data. This scoping information and the POA&M and the Master Sequence Network of Appendix E provide a preliminary basis for estimating the scope and a schedule, and give an indication of the resources required to develop an EOC program.

2.4 EOC PROGRAM STRUCTURE

2.4.1 General

The initiation of an EOC program represents a major commitment by the Navy to allocate significant resources to improve the material condition of a designated class or category of ship. A typical EOC program is a multi-year effort consisting of a one-year Initiation Phase, a two-year Development Phase (extending to additional years as subsequent classes of ships are added), and an Implementation Phase that will extend through the remaining life of the ship classes involved. Figure 2-1 depicts a typical program schedule. An EOC program may maximize a ship's availability by lengthening the time between Regular Overhauls and, if required, assigning a number of short-length Selected Restricted Availabilities (SRAs) for the performance of necessary maintenance on those equipments which cannot operate for a full extended cycle without IMA or depot level maintenance. The EOC program for a ship may be preceded by an overhaul to bring the ship to a level of acceptable material condition before it enters the EOC. This pre-EOC period and a typical operating cycle for a ship entering and proceeding through an EOC are shown in Figure 2-2.

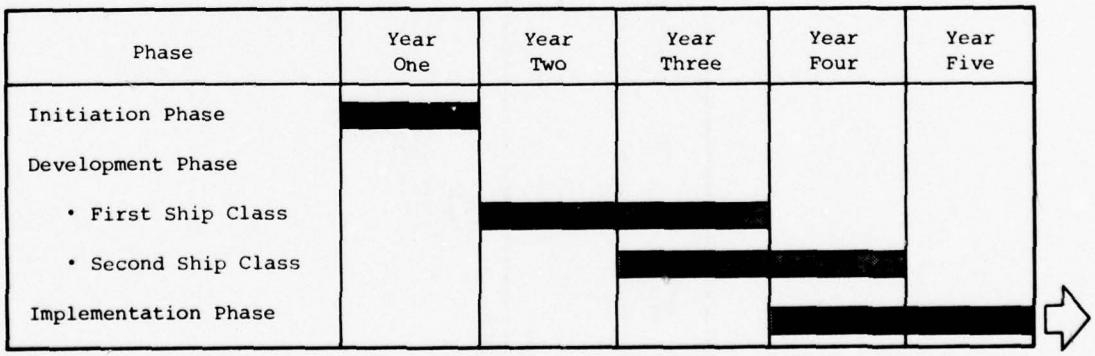


Figure 2-1. TYPICAL ENGINEERED OPERATING CYCLE PROGRAM SCHEDULE

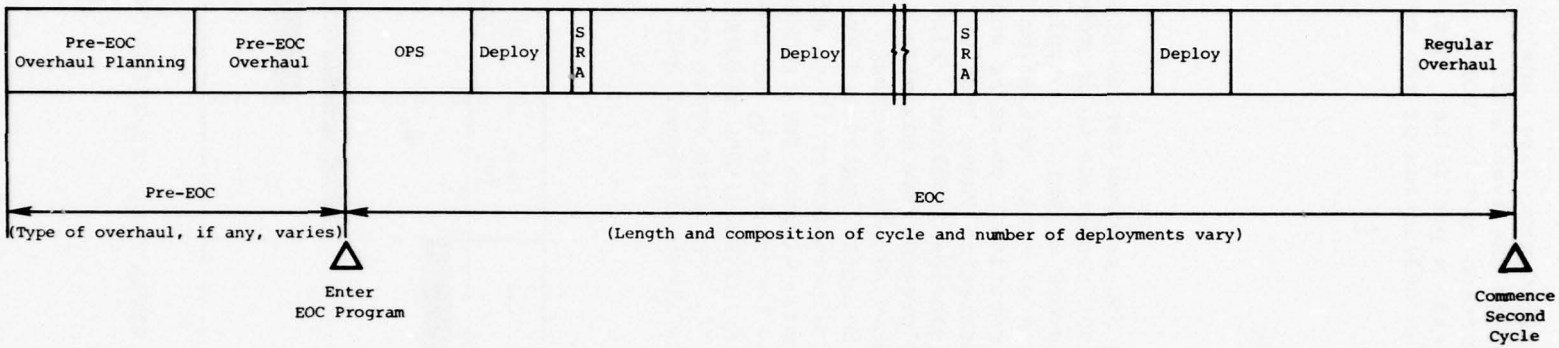


Figure 2-2. TYPICAL EOC PROGRAM SHIP SCHEDULE

2.4.2 Initiation Phase

The objective of each program phase is attained through a combination of engineering, analytical, and management processes. During the Initiation Phase (Figure 2-3) ship data are collected and objectives and constraints that will guide the EOC program are defined. The current status of the ship's material condition and its overall maintenance strategy are assessed. Alternative maintenance strategies are identified and from them the preliminary EOC maintenance strategy is defined. The existing and proposed maintenance strategies are compared and analyzed and the feasibility of adopting an EOC program is evaluated.

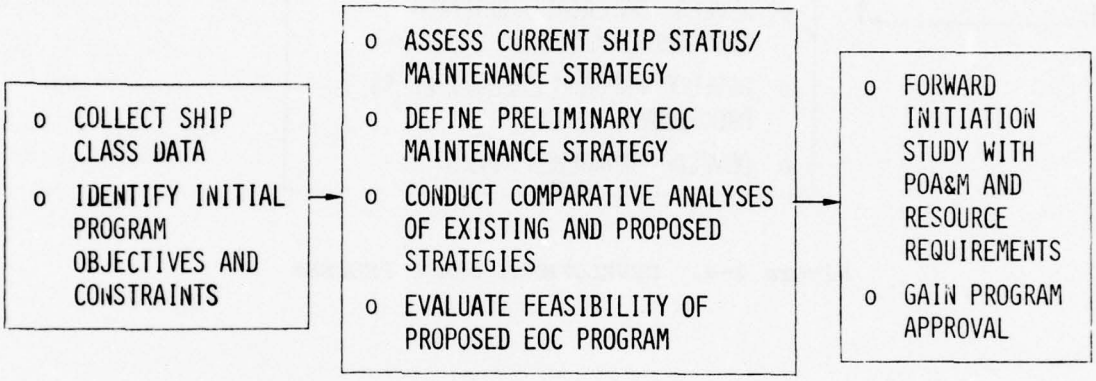


Figure 2-3. INITIATION PHASE PROCESS

The final product of these activities is the Initiation Study, which is forwarded for final review and approval. The study contains the preliminary EOC maintenance strategy, engineering and resource requirements, and a plan of action and milestones toward the accomplishment of the EOC.

2.4.3 Development Phase

During the Development Phase (Figure 2-4) detailed engineering efforts go into a thorough development and evaluation of the specifics of the approved EOC maintenance strategy. Pertinent, detailed technical, operational, and experience data are assembled and from those data, critical equipments and systems are selected, beneficial technical and Fleet Modernization Program (FMP) alterations are identified, and maintenance requirements for pre-EOC overhauls are developed. Detailed systems engineering analyses are performed on selected critical equipments, with specific restorative and corrective maintenance requirements identified in the development of the class maintenance plans. Standards of material condition assessment (MCA) and program effectiveness are developed to permit the analysis of the efforts and results of the EOC program and to modify the efforts as

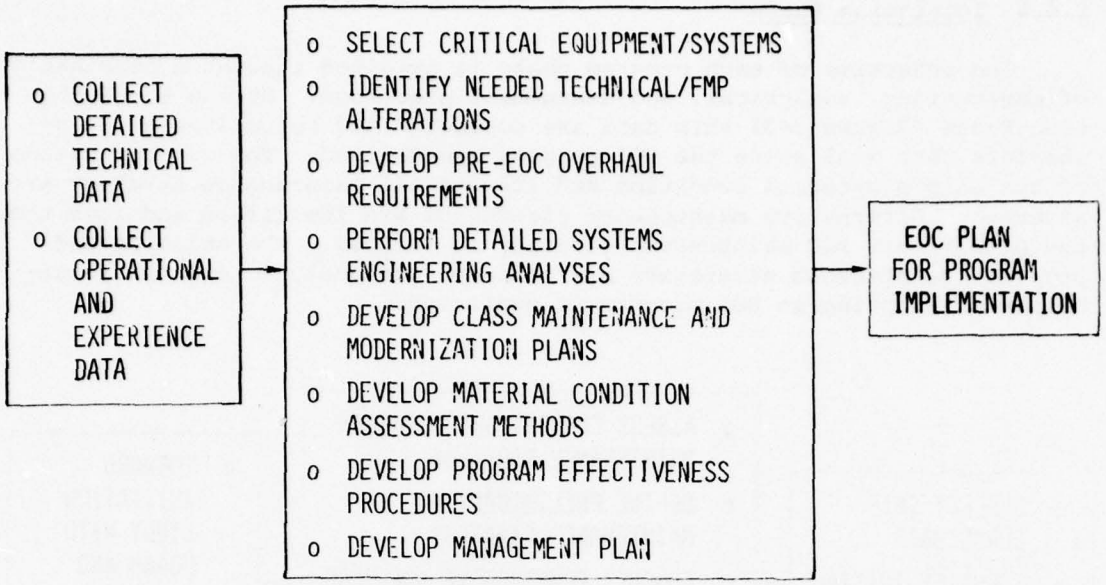


Figure 2-4. DEVELOPMENT PHASE PROCESS

necessary. The EOC Management Plan provides guidance in program administration, planning, execution, and support. Together, these elements constitute the EOC plan that is implemented in the Implementation Phase.

2.4.4 Implementation Phase

During the Implementation Phase (Figure 2-5), each ship will be given a pre-EOC overhaul (if required) before entering its own Engineered Operating Cycle. EOC support elements and organizations, including the Central Technical Group and Site Teams, should be formally established to continue the coordination and integration of the EOC program with existing maintenance programs. The program should be continually analyzed on the basis of feedback received from material condition assessments and post-overhaul, trend, and program-effectiveness analyses. The results of these analyses should be used to support the management of the program and show where modification is required.

2.4.5 Principal Milestones

The principal milestones of a typical EOC program are shown in Figure 2-6. The Initiation Study requires approximately eight months to complete, leaving four months in which to review and approve recommendations of the study and formally establish the program. The Development Phase,

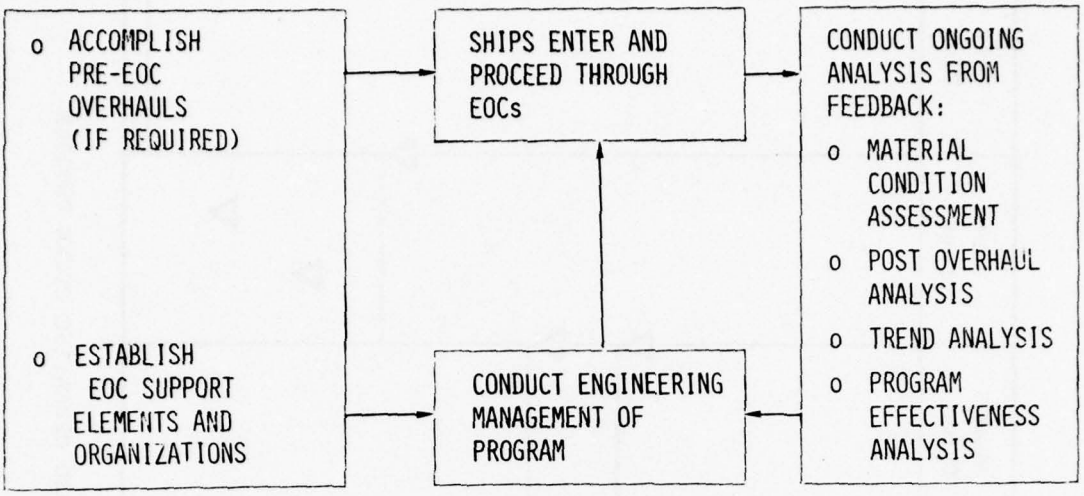


Figure 2-5. IMPLEMENTATION PHASE PROCESS

consisting of detailed engineering analyses, requires about two years for each class of ship. During this time pre-EOC overhaul planning should be conducted for the first ships entering the program. If they are necessary, typical pre-EOC overhauls require about 12 months to complete. During this time, and before the first ship enters its EOC, a Central Technical Group and Site Teams (or similar organizations) are established.

2.4.6 Technical Approach

Details of the technical approach to be used in developing an EOC program are outlined in succeeding chapters of this manual. Guidelines for initiating, developing, and implementing an EOC program are provided in Chapters Three, Four and Five. Chapter Six presents an EOC program management overview, and the appendixes provide additional reference and bibliographical information.

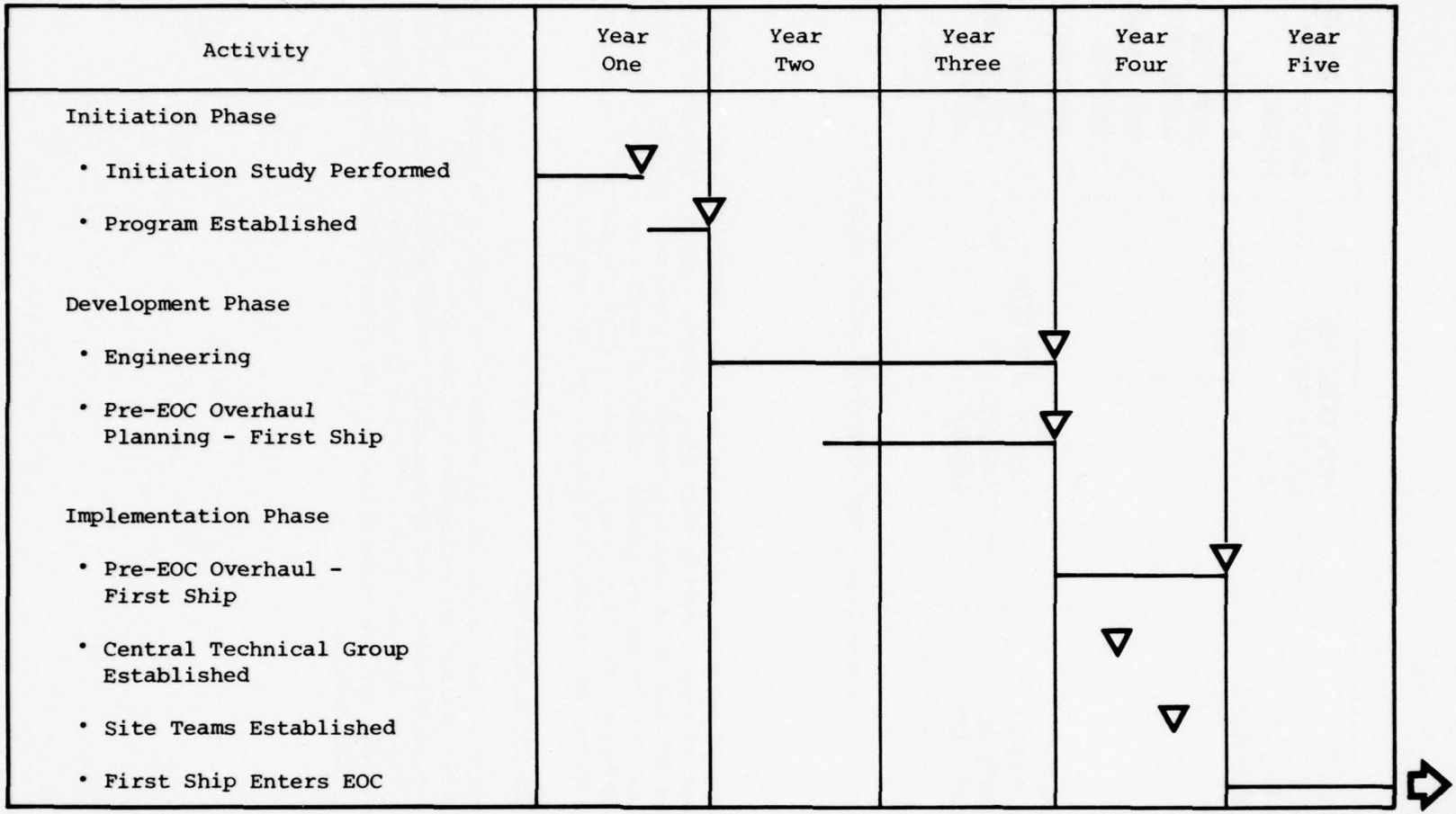


Figure 2-6. PRINCIPAL MILESTONES OF A TYPICAL ENGINEERED OPERATING CYCLE PROGRAM

CHAPTER THREE

INITIATION PHASE

3.1 INTRODUCTION

This chapter describes the process by which an EOC program is initiated. It describes the research required to establish the current ship class status and the analyses required to identify and select a feasible preliminary EOC maintenance strategy. It suggests procedures for recommending a preliminary EOC maintenance strategy and for seeking Headquarters approval, and it suggests documentation for aiding the transition of the program into the Development Phase.

3.2 INITIATION PHASE PROCESS

An EOC program commences with a Navy directive to investigate the feasibility of an EOC for a given class of ships. Program objectives and constraints are specified to some degree of detail. The Initiation Phase then commences with an Initiation Study as illustrated in Figure 3-1. (The figure has been placed at the end of the chapter as a fold-out page so it can be kept in view while the rest of this chapter is being read.)

This study consists of identifying specific EOC program objectives and constraints in quantifiable terms of operational requirements, material condition, cost, etc. Typical examples of objectives and constraints are discussed in Section 3.3. The ship class data required to determine ship class configuration and to assess the ship class status, relative to the objectives and constraints, are identified and gathered. The data are compiled and summarized to determine the current maintenance strategy and to assess the resultant material condition of the class, considering the effect of the FMP and the expected ship class life. In addition, the data are analyzed to determine the cost and effectiveness of the current maintenance strategy. On the basis of shortcomings of the current strategy, alternatives are examined and evaluated and a preliminary EOC strategy is selected. Its resource requirements and effectiveness are also estimated, then compared to those of the current strategy. The feasibility of the EOC strategy is then determined on the basis of the benefits gained versus the resources required.

If the preliminary strategy is not considered feasible, the selection and comparison process is repeated to identify a more suitable alternative. If no suitable alternative can be found, the current process is documented in the Initiation Study Report and the process ends. If a suitable alternative strategy is found, it is recommended in the Initiation Study Report and submitted for approval. After approval, POM inputs are generated and the Development Phase Requirements are documented. If the proposed strategy is disapproved, the associated reasons are analyzed and used to modify the program objectives and constraints, and the preliminary EOC maintenance strategy selection process is repeated.

3.3 PROGRAM OBJECTIVES AND CONSTRAINTS

To investigate the feasibility of adopting an EOC maintenance strategy for any class of ships, initial program objectives and constraints must be defined. The guidance may be a very specific statement (e.g., "Extend present operating cycle to *X* months") or general in nature (e.g., "Improve material condition of the class, maintaining present operational availability at acceptable costs"). The specificity of each program's initial objectives and constraints can be expected to vary from one ship class to another. For any EOC program, the initial program objectives and constraints must remain general enough to maximize both the program flexibility and the number of feasible engineering alternatives to maintenance strategies. The following typical objectives and constraints may be expected:

- Objectives
  - Improve class material condition
  - Define a class long-range maintenance plan
  - Increase peacetime operational availability
  - Increase mission readiness
  - Reduce existing maintenance costs
  - Reduce existing maintenance burden
  - Extend operating cycle
- Constraints
  - Costs
  - Shipboard manning levels
  - Overhaul cycle
  - Requirement to conduct specific availabilities (e.g., BOHs, SRAs)

- Capacity and capability of organizational, IMA, and depot activities
- Mandatory system design or alteration changes
- Limited maintenance availabilities during EOC
- Operational deployment cycle

3.4 DATA CHARACTERISTICS AND COLLECTION

The type of data required during the development of an EOC program is dictated by the EOC objectives and constraints and the associated analyses to be performed. The sources of those data, however, depend on the extent of operational history of the ship class. For example, if the objective of an EOC were to extend the operating cycle, reliability, maintainability, and availability (RMA) data would have to be analyzed to determine if the ships' equipment and systems are inherently capable of such extended operation or to determine what actions would be required to permit such extended operation. For ships with a significant operational history, the actual ship operational and maintenance data are usually the best source of RMA data. For new ships with little or no operational data, the prime source of RMA data is the design data (available in the form of RMA evaluations performed by the ship design activity) and the design specifications, including the Top Level Specifications, Top Level Requirements, and the Detailed Shipbuilding Specifications.

3.4.1 Data Characteristics

EOC programs are developed for a ship class. Therefore any analysis performed and conclusions drawn must derive from the entire class. It follows then that the associated data going into the analysis must also be representative of the class; in addition, the data must be accurate and valid. These characteristics must be considered and verified during the data identification, selection, and collection process. Due to changing conditions and human error, not all reported data are valid, accurate, and representative.

Validity of data, as used herein, means that the data apply to the intended configuration (present or future) of the ship class. Analysis of data that are invalid because of past or planned alterations to a ship class could result in the identification of a maintenance problem that has already been resolved or whose resolution has already been planned. This validity requirement, then, establishes a requirement for data specifying the present and future configuration of the ship class.

Accuracy of data is very difficult to ascertain. This is particularly true when the data consist of subjective evaluations. Whenever practical, several different sources should be used and the data should be examined for consistency. Inconsistent data should be regarded as suspect, and if the inconsistencies cannot be adjudicated, conclusions should be given an appropriate caveat. Although the preceding applies primarily to historical data, inaccuracies also exist in design data. Assumptions and sources

of information used in the development of design data must often be checked. Comparisons with historical data for similar equipment and systems in other ship classes can often provide valuable evidence as to data accuracy. Care must be exercised in these comparisons, however, to ensure that the conditions under which the equipment and systems are compared are sufficiently similar to permit meaningful conclusions.

Representative data are absolutely essential in any analysis. Conclusions based on anomalous conditions not representative of the ship class can adversely affect an EOC program. Therefore, great care should be taken to select data weighted in proportion to existing conditions. Some examples of differing conditions are: East Coast deployment schedules versus West Coast deployment schedules (see Appendix B), major differences in propulsion plant configurations within a class, intensity of operations from one time period to another (Vietnam period versus peacetime). Where the bias of an unusual condition is unavoidable, the bias should be clearly identified in any use of the data.

3.4.2 Data Collection

Collection of ship class data encompasses identification, selection, and collection of those data required to support the entire Initiation Phase process. To the extent specified in the program objectives and constraints, three separate applications need to be considered and provided for in this process. They are the determination of the current status of maintenance strategy and material condition, selection of a preliminary EOC strategy, and measurement of the resource requirements for both the current and preliminary EOC maintenance strategies. The lead time needed for getting much of this information requires that this process be given priority and high visibility at the very beginning of the program development.

The data required to determine maintenance strategies must quantify the Level, Method, and Timing of Repair (LOR, MOR, TOR) and define the Ship Operating Cycle. The data must therefore include the amount of maintenance performed, the level (organization, IMA, or depot) at which it is performed, the method of its performance, and the method of scheduling its performance (see Appendix B). Actual ship class historical data are the preferred source of information. If, however, the operational history is insufficient to provide those data, ship class design data may be studied instead. Appendix C suggests sources of maintenance strategy data.

The data required to determine material condition consist primarily of RMA type data, i.e., number of failures, amount of downtime, time to repair, etc. Again, ship class historical data are the preferred source of information. If, however, the operational history is insufficient to provide those data, ship class design data may be studied instead. Appendix C suggests sources for RMA data.

To determine resource requirements, the data must make clear the number of men and the amounts of money and time required to maintain the specified ships. The sources must include those at each maintenance level, organization, IMA, and depot. Here again, ship class historical data are preferred. However, planning yard design data coupled with TYCOM and Headquarters planning data may be substituted. Appendix C suggests sources for resource requirements data.

3.5 CURRENT STATUS ASSESSMENT

During this portion of the Initiation Study, to the extent specified in the program objectives and constraints, the data that have been gathered are summarized and analyzed to determine the ship class configuration (present and anticipated), maintenance strategy, material condition, and expected life. The analyses also provide a basis for recognizing problems in the current maintenance strategy and for selecting an appropriate preliminary EOC strategy.

3.5.1 Ship Class Configuration

The current ship class configuration can be determined from the latest SECAS reports. To properly estimate the resource requirements and effectiveness of maintenance strategies representative of the future ship class configuration, anticipated modifications resulting from the FMP and other specific ship class modernization programs must be studied. Therefore, the planned changes in ship configuration must be obtained from SAMIS and the SLMs before completing the estimate of program resource requirements and program effectiveness.

3.5.2 Maintenance Strategy

During this part of the Initiation Study, it will be necessary to compile data regarding the amount of maintenance performed and the elements of that maintenance as defined in Appendix B. In some cases, the same type of data may be required in two or more forms, e.g., amount of maintenance in maintenance man-hours and in dollars. Recording the data in quantifiable values such as man-hours or dollars is an important step in making them comparable.

Historical data, although more difficult to acquire and compile, should be analyzed wherever practical. However, lacking historical data, design data may be substituted. The absolute values used in defining the maintenance strategy are important, but must be considered suspect because they may not be accurate or complete. Of greater importance are the comparisons of the parts to the whole, e.g., the ratios of the total maintenance performed at the organizational level and at the IMA level, the ratios of the operating cycle employed for IMA availabilities and for depot availabilities. These ratios will be changed for the EOC strategy to rectify certain deficiencies in material condition, operating cycle, ship availability, etc., to attain the program objectives.

3.5.3 Material Condition

During this portion of the Initiation Study various data are analyzed to determine the ship class material condition. A conclusion that the condition is unsatisfactory should be based on sufficient historical or design information to support such a conclusion.

Material condition data consist basically of two types: raw RMA data whose analysis indicates material condition, (e.g., MDS data, CASREP data, R&M validation test data) and evaluation or inspection data whose summary specifies satisfactory or unsatisfactory material condition (e.g., INSURV inspections, PEB/LOE, FORSTATs). Both types of data should be studied and conclusions reached from them compared to determine their consistency. If the results are inconsistent, the data should be considered suspect and the reasons for inconsistency adjudicated. Deficiencies in material condition identified should be checked against the FMP to note any existing plans to eliminate them. In addition, expected life of the ship class should be estimated on the basis of its current material condition and on the employment plans of Headquarters and TYCOM organizations.

3.6 CURRENT PROGRAM EFFECTIVENESS AND RESOURCE REQUIREMENTS ESTIMATE

This portion of the Initiation Study should evaluate the effectiveness of the current maintenance strategy and estimate the cost of that effectiveness. The effectiveness of the current maintenance strategy is measurable in terms of availability, defined as that percentage of time a ship class is either fully or substantially ready to perform its primary mission. States of readiness and the events assumed for each state are shown in Table 3-1 and correspond to the FORSTAT readiness and reporting system. Historical data should be used to the maximum extent. If insufficient historical data exist, planning information (in the form of TYCOM Notional Schedules) or design information may be used.

Resource requirements for current maintenance strategies are generally well documented (see Appendix C). Resource requirements for organizational, IMA, and depot level maintenance should be summed, including the cost of labor and of materials, and projected over the expected life cycle of the ship. Where insufficient historical data exist to permit the extrapolation of future requirements, TYCOM planning information may be substituted.

3.7 PRELIMINARY EOC MAINTENANCE STRATEGY DEFINITION

Deficiencies in the current ship class material condition are analyzed and the probable causes of those deficiencies are identified and classified. Alternative maintenance strategies (Appendix B) are then investigated to determine the extent to which each rectifies the material condition deficiencies and to which each achieves the EOC program objectives (within the

Table 3-1. READINESS STATES AND RELATED EVENTS

State	Events
1. Fully Ready	Deployed En route Fleet Operations
2. Substantially Ready	Technical Availability Prepare for Overseas Movement Leave and Upkeep Operational Propulsion Plant Exam Training (other than refresher training)
3. Marginally Ready	Period after overhaul until completion of refresher training (REFTRA). Includes Ship Qualification Trials, REFTRA, Restricted Availability, Training, Upkeep Restricted Availabilities (including SRAs) Intermediate Maintenance Periods
4. Not Ready	Regular or Baseline Overhaul

specified constraints). The most suitable alternative is identified and documented as the preliminary EOC maintenance strategy. If none of the alternatives is considered suitable, a new strategy is created by selecting each strategy element to resolve each previously identified deficiency and satisfy each EOC program objective within the specified program constraints. This then is identified as the preliminary EOC strategy.

3.8 EOC PROGRAM EFFECTIVENESS AND RESOURCE REQUIREMENTS ESTIMATE

Using the same procedure and bases as specified in Section 3.6, the effectiveness and resource requirements for the preliminary EOC strategy are identified and documented.

3.9 COMPARATIVE ANALYSIS

Previous analyses have measured the effectiveness of the current and of the preliminary EOC strategies and the resource requirements of each. During this part of the Initiation Study, the effectiveness and resource requirements of each strategy are compared and conclusions are drawn relative to the feasibility of implementing the preliminary EOC strategy. Two methods of comparison are suggested.

The first method relates the total strategy maintenance cost to the resulting ship class availability for each strategy. It is calculated by dividing the total maintenance cost (in dollars) by the ship availability (in percent). The difference in costs between the two strategies is then compared for significance.

The second method consists of comparing the cost of an EOC strategy with the cost of acquiring and operating additional ships to give the same increased ship availability as would result from the EOC strategy.

It is determined by predicting the increase in ship availability that will result from implementation of an EOC maintenance strategy, converting that increase to an equivalent number of additional ships (based on current availability), then calculating the cost of acquiring and maintaining those additional ships. Acquisition costs should be based on current experience for comparable ships. Average annual direct operating costs may be obtained from the current Navy Program Factors Manual (OPNAV 90P-02). To determine the value of an EOC maintenance strategy, the operational and maintenance cost of the hypothetical larger fleet (without EOC) is compared to that of the existing fleet (with an EOC). That value is predicated on the premise that with an EOC maintenance strategy, the present fleet can accomplish as much as a fleet with "X" more ships. This calculation does not completely take into account improved ship material condition resulting from more frequent depot availabilities keeping the ships closer to optimum condition. (Current strategies require more time between depot availabilities, but longer availabilities,)

Whichever method is selected, the results should include a statement regarding assumptions and caveats appropriate to the conclusions. For example, the conclusions might be based on an anticipated or recommended increase in IMA capacity or on certain data whose accuracy is suspect due to conflicting reports or evaluations.

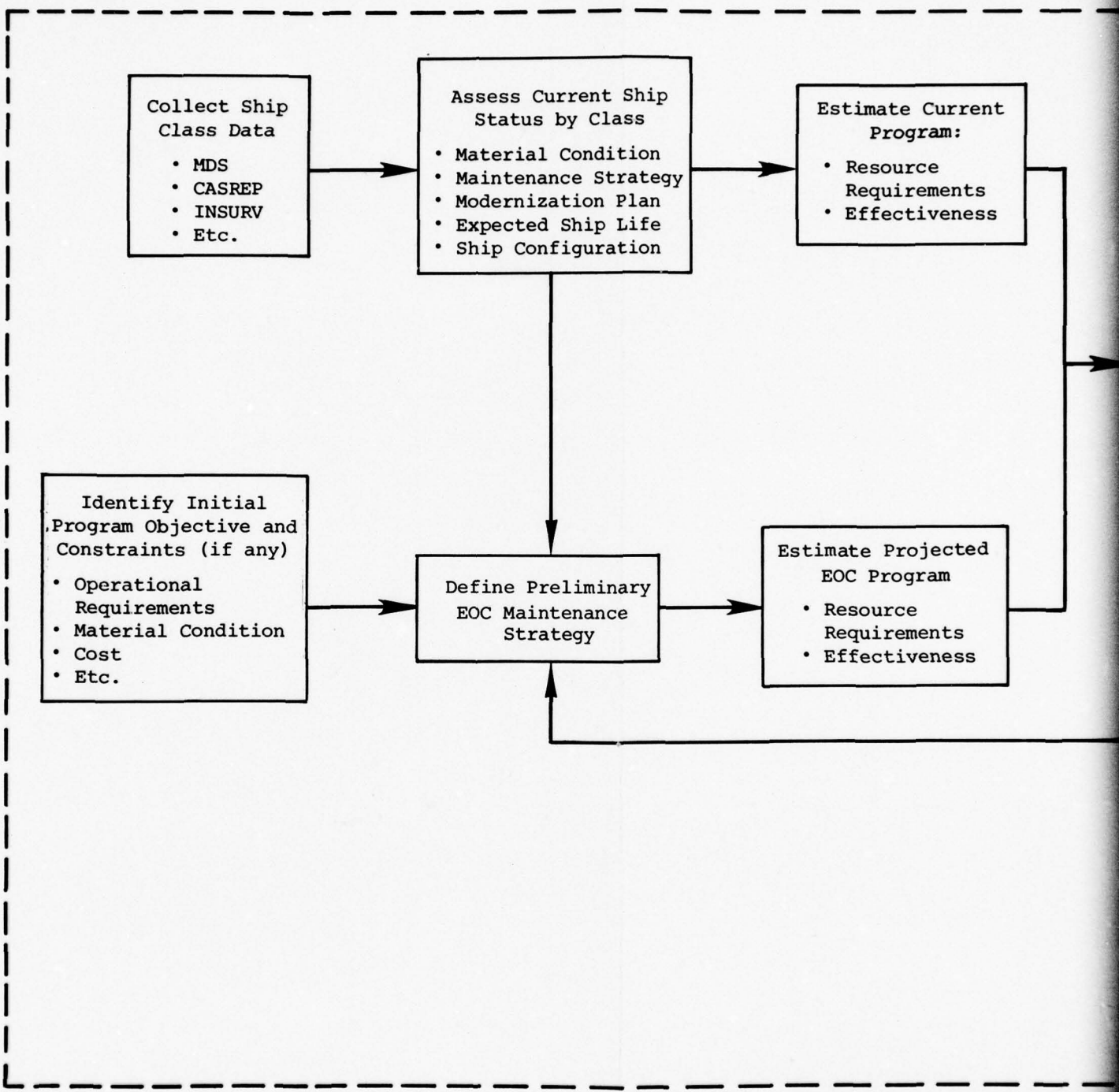
Should the evaluation indicate that initiation of the preliminary EOC strategy is not feasible, the reasons for the infeasibility are determined and the process of searching for a feasible preliminary EOC strategy is repeated.

3.10 DOCUMENTATION OF EOC PROGRAM RECOMMENDATIONS

During this part of the Initiation Study, the conclusions and recommendations are documented in the Initiation Study Report. Feasible preliminary EOC maintenance strategy is described along with its estimated resource requirements. In addition, the planning and engineering requirements of the Development Phase are identified, and an EOC program POA&M is created. The requirements are obtained from a review of the Development Phase requirements identified in Chapter Four, and the POA&M from the guidance in Appendix E, both in light of the EOC program objectives and constraints.

3.11 INITIATION STUDY REVIEW AND APPROVAL PROCESS

The Initiation Study Report is forwarded to the Navy Headquarters organizations for review and approval. Once initiation of an EOC program is approved the report of resource requirements and POA&M are utilized to update the Navy POM to provide budgetary planning. In addition, a Development Phase Requirements document is prepared to assist in the transition of the program from the Initiation Phase to the Development Phase. It specifies the planning and engineering requirements for the Development Phase, the resource requirements for the program, and the POA&M.


Collect Ship Class Data
• MDS
• CASREP
• INSURV
• Etc.
Assess Current Ship Status by Class
• Material Condition
• Maintenance Strategy
• Modernization Plan
• Expected Ship Life
• Ship Configuration
Estimate Current Program:
• Resource Requirements
• Effectiveness
Identify Initial Program Objective and Constraints (if any)
• Operational Requirements
• Material Condition
• Cost
• Etc.
Define Preliminary EOC Maintenance Strategy
Estimate Projected EOC Program
• Resource Requirements
• Effectiveness

Figure

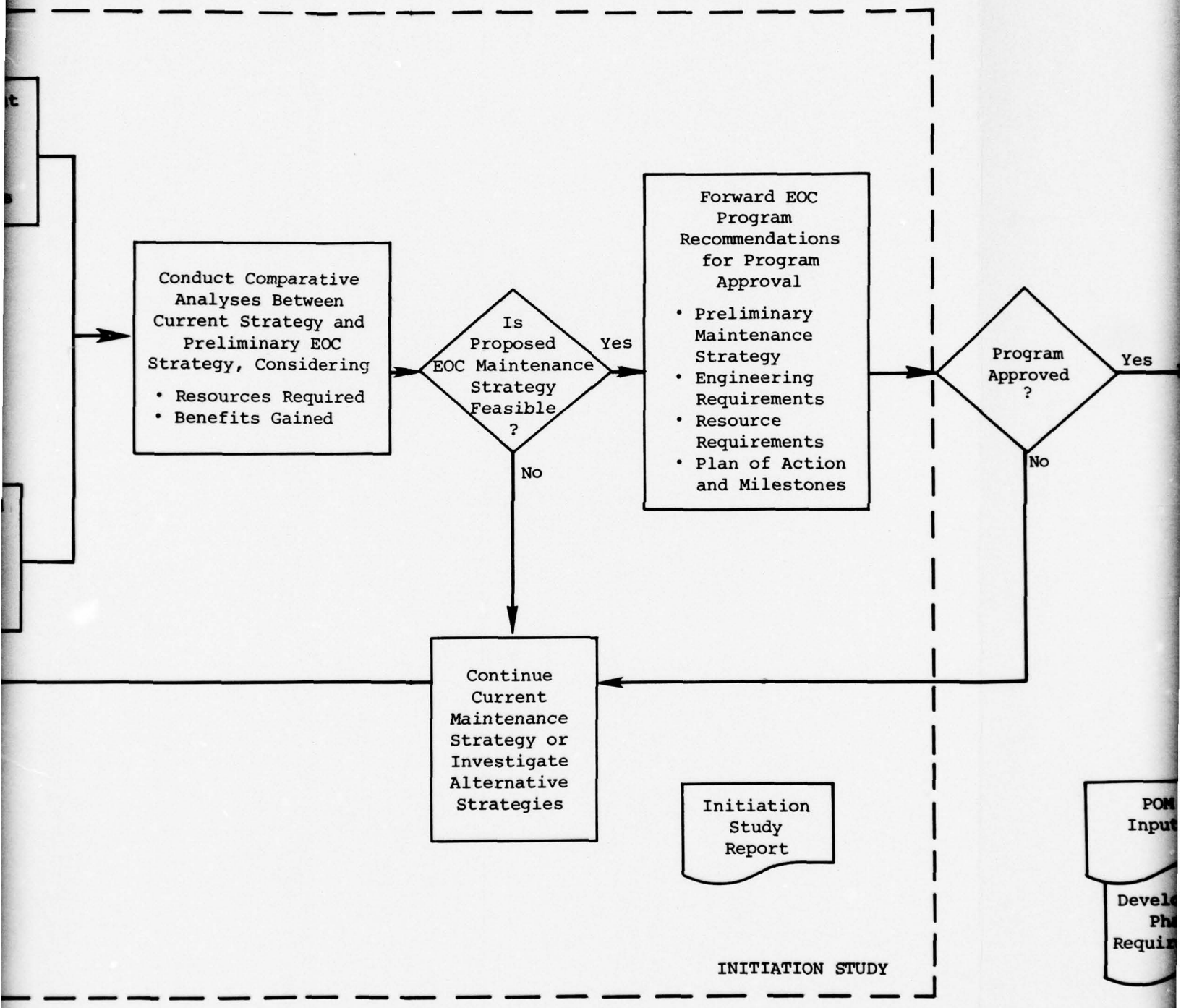
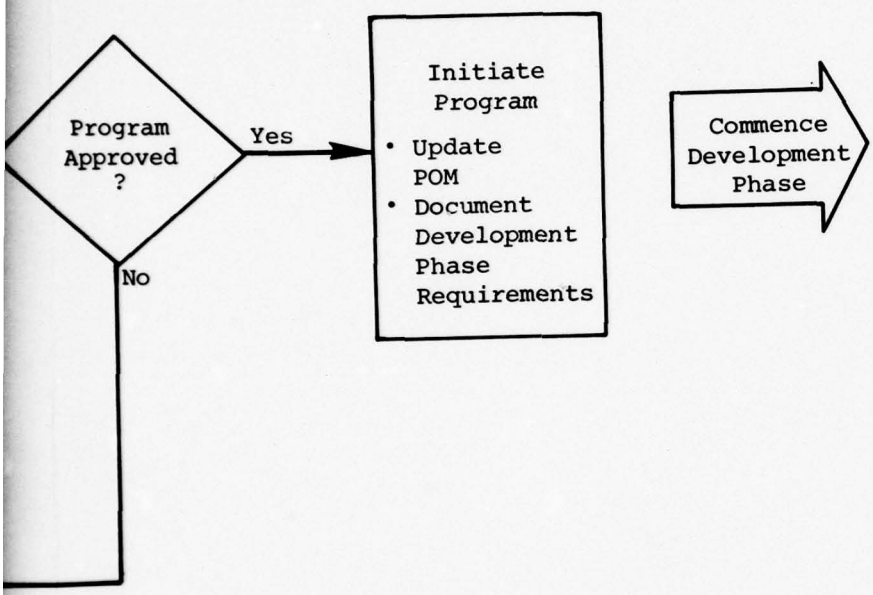
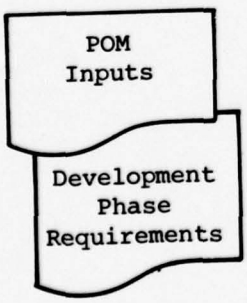


Figure 3-1. PROCESS DIAGRAM: EOC PROGRAM INITIATION PHASE


Program Approved ?
Yes
No
Initiate Program
• Update POM
• Document Development Phase Requirements
Commence Development Phase


POM Inputs
Development Phase Requirements

CHAPTER FOUR

DEVELOPMENT PHASE

4.1 INTRODUCTION

This chapter describes the necessary engineering studies, maintenance plans, and program management and evaluation processes required for the detailed design and management of an EOC program. It also describes the processes by which the following documents are produced during the EOC program Development Phase:

- Alteration List
- Critical Equipments/Systems List
- Engineering Analyses
- Screened Repairable Change-Out Equipment List
- Pre-EOC Overhaul Requirements
- Class Maintenance Plan
- Management Plan
- MCA Procedures
- Post-Overhaul Analysis Program
- Program Effectiveness Procedures
- EOC Plan

The degree to which each of these documents or procedures applies to any specified EOC program will vary according to the program objectives and constraints.

4.2 DEVELOPMENT PHASE PROCESS

The Development Phase consists of the analyses and preparation of documents for an EOC program as specified in the Development Phase requirements document prepared during the Initiation Phase. Using that document as a guide, the Development Phase process, illustrated in Figure 4-1, begins with the collection of detailed maintenance data for the ship class to supplement the data acquired during the Initiation Phase. (The figure has been

placed at the end of the chapter as a fold-out page so it can be kept in view while the rest of this chapter is being read.) The data should support:

- Determination of class configuration
- Identification of equipments and systems that need analysis
- Performance of system engineering analyses
- Development of resource requirements
- Development of program monitoring procedures
- Development of management procedures

Because future ship class configuration is an important factor in the planning of a maintenance strategy, FMP changes are identified and their effects are analyzed. In addition, existing alterations not in the ship class FMP are thoroughly investigated and those that offer significant increases in R&M are recommended for implementation.

To concentrate engineering effort on the most significant maintenance-related problems, systems and equipments that have contributed or have the greatest potential to contribute to unsatisfactory ship class conditions are identified as "critical" systems and equipment - critical being defined in relation to the EOC program objectives and constraints.

The system engineering analysis requirements are then refined by identifying which critical systems and equipments to analyze and what analytical techniques to use. The selection of the systems and equipments is a function of the anticipated ship class configuration, the degree of improvement (relative to the objectives) which can be expected, and the resources available. The selection of analytical techniques is primarily a function of the type and form of the maintenance data available. Appendix G provides details of an analytical technique utilizing engineering and economic criteria for repairable change-out equipment selection.

The system engineering analyses consist of the application of engineering and analytical techniques to the selected critical systems and equipments to establish a maintenance policy and maintenance standards; identify overhaul requirements, ILS change requirements, and potential MCA requirements; and to identify and develop PMS change requirements.

If analyses determine that a pre-EOC overhaul is necessary to raise the ship class to an acceptable material condition, the requirements for the overhaul are developed by identifying repair and alteration requirements, Technical Repair Standard (TRS) and POT&I requirements, and post-overhaul test and certification (T&C) requirements. TRSs and T&C documents must then be funded and prepared in time to support the pre-EOC overhaul.

After the system engineering analyses have been performed and the alteration requirements identified, a CMP can be developed to specify the total system maintenance requirements, including resource requirements and frequency. In addition, the CMP will specify R&M alterations to be performed.

Development of the Management Plan may begin at this point in the Development Phase. This effort is anomalous because it does not involve development of an engineering output supportive of the maintenance strategy but rather serves as a guide for the accomplishment of the engineering functions. The EOC Management Plan should be the Program Manager's principal guide for planning for all aspects of the EOC. It should identify program functions, assignments and responsibilities, and the EOC management organization. In addition it should deal with maintenance management, resource management, program evaluation, management information systems, and the relationship of the EOC program to existing maintenance programs.

During the system engineering analyses, certain systems and equipments were identified for which it is desirable and feasible to predict the need for maintenance with MCA. At this point in the Development Phase, MCA procedures are developed, including those for continuously monitoring the system and equipment condition during the operating cycle, those for performing trend analyses to predict material deterioration with time, and those special procedures performed at particular intervals during the operating cycle by the Site Teams. The development of these procedures depends to a great extent on assessment procedures that are part of such other existing programs as TSTP and PMS.

During the post-overhaul analysis program, the repair work and alterations performed are recorded and compared to those that were scheduled, and the ship material condition is recorded. This program therefore documents the basic configuration of each ship and its material condition as it enters the EOC.

Program effectiveness procedures are developed by EOC program managers to predict the effectiveness of the EOC program as it is being developed and to substantiate its effectiveness after a ship class has been operating in an EOC for some time. The EOC program can be adjusted should the predicted or actual effectiveness decrease from that earlier predicted or experienced. Program effectiveness procedures developed for existing EOC programs should be reviewed and standard effectiveness procedures utilized where feasible.

The final effort of the Development Phase is to prepare the EOC Plan, which, among other things, assembles under one cover the Development Phase documents to be used during the Implementation Phase. In addition it describes the Implementation Phase requirements and schedule as they apply to a particular ship class, the product of reviewing the Implementation Phase requirements in light of the EOC program objectives and constraints. The EOC Plan serves to guide the transition from the Development Phase to the Implementation Phase. The remaining sections of this chapter are organized in the sequence of the processes depicted in Figure 4-1. The products of each of those processes are shown at the bottom of the figure.

4.3 DEVELOPMENT PHASE DATA COLLECTION

This section addresses the data required to complete the EOC program Development Phase. It is imperative that the data gathered

for the Initiation Phase (see Chapter Three) remain available for use as baseline during this phase; consequently only requirements for additional or updated data will be addressed in this section. The following categories of additional data will be needed: configuration data, current maintenance strategy data, ship system technical data, performance and material condition assessment data, ship modernization data, and Integrated Logistics Support (ILS) data. The Chapter Three discussion of data characteristics is appropriate for data collected during the Development Phases, also. Specific data sources by category are suggested in Appendix C.

4.3.1 Configuration Data

Detailed ship system configuration data are required during engineering analyses. A principal source of these data is the Type Commander's COSAL, which categorizes equipment Allowance Parts Lists (APLs) by system nomenclature, by equipment nomenclature, and by APL number.

4.3.2 Current Maintenance Strategy Data

The performance of engineering analyses, development of a Class Maintenance Plan, and implementation of Material Condition Assessment procedures will require Planned Maintenance System data for each ship being analyzed specifying the maintenance that has been systematically prearranged for the class. A complete set of current Maintenance Index Pages (MIPs) and Maintenance Requirement Cards (MRCs) for each ship class should be obtained for use in the development of various documents and engineering analyses.

4.3.3 Ship System Technical Data

Detailed technical information about the operation and maintenance of ship systems will be required during engineering analyses and determination of Material Condition Assessment procedures. Additional documents that would support those efforts are System and Equipment Technical Manuals, Ship Information Books (SIBs), Technical Repair Standards, Military Specifications (MIL-SPECs), and Military Standards. These documents contain information about construction, operation, and performance that will greatly aid the various analysis efforts, especially for those classes of ships that have no historical data.

4.3.4 Performance/Material Condition Assessment Data

The primary data in this category are the CASREP data obtained in the Initiation Phase. If detailed CASREP narratives covering all EICs and all ships of the class were not previously obtained, they should be procured at this time to permit the analysis of system failure modes, logistics support, and downtime.

Numerous other sources of performance and material condition assessment data are available and should be considered for their applicability and utility to the EOC program. The following sources suggest some of the various types of data that should be considered: Ship Qualification Trial Reports, Combat System Readiness Reviews and Tests, Total Ship Test

Program Test Reports, FORSTAT Reports, TYCOM Inspection Reports, Gun Weapon System Replacement Program Material Inspections, Fleet Missile System Analyses and Evaluation Group Technical Reports, and Electronic Information Maintenance Bulletins (EIMBs).

4.3.5 Ship Modernization Data

Detailed ship alteration information is required to establish the class configuration and refine engineering analyses requirements. The Ship Alteration Management Information System (SAMIS), Alteration Records, and the Fleet Modernization Program obtained during the Initiation Phase are the primary sources of such information. However, only current documents should be used in any analysis. Additional detailed ship alteration information can be obtained from the Ship Alteration Information Manual maintained by the cognizant PERA, and detailed information on ordnance alterations can be obtained through the Weapons System Engineering Directorate at NAVSEA.

4.3.6 Integrated Logistic Support (ILS) Data

In-depth ILS data are required for the completion of engineering analyses. The Navy Ship's Parts Control Center (SPCC) produces several ILS products on microfiche. Those of use to the EOC program are APLs, Master Index of APLs (MIAPL), Navy Management Data List (NMDL), and the Standard Navy Stock List (SNSL). In addition, many reports are available that provide data on the effectiveness of various ILS elements, e.g., spare parts usage and availability, configuration, manning, and INSURV data support elements. These reports are described in Navy Fleet Material Support Office Instruction 4790.2 and are available from MSO, Mechanicsburg, Pennsylvania.

4.4 DETERMINATION OF ALTERATION REQUIREMENTS

Improvements to active and reserve Fleet ships are specified in ship alterations (ShipAlts) and ordnance alterations (OrdAlts). The majority of these alterations are programmed into the Fleet Modernization Plan, a multi-year program managed and controlled by the CNO, who has the responsibility for planning, programming, budgeting, and implementing the improvements. To meet this responsibility, extensive information support from elements of CNO, the Fleet Commanders in Chief (FLTCINCs), Type Commanders, and the Chief of Naval Material (CNM) is required. To ensure that an EOC program properly reflects the updated ship class configuration, the FMP alterations must be reviewed and their impact determined. In addition, to capitalize on existing solutions to previously identified ship class reliability and maintainability problems, an alteration identification process is initiated to identify a comprehensive list of class-applicable alterations recommended for installation in support of the objectives of the EOC program's maintenance strategy.

The Fleet Modernization data should be thoroughly researched to identify the class-applicable reliability and maintainability alterations deemed necessary to support the objectives of the class maintenance strategy. These alterations are ranked in order of the support they provide for

relieving problems identified during the Initiation Phase. As the list of maintenance-critical equipments and systems is developed the final ranking of the alterations should be rearranged to align with the results of that effort.

The Fleet Modernization Plan is reviewed to identify alterations with funding authorization and fiscal year scheduling already assigned. An Alteration List is prepared to identify the recommended ShipAlts and OrdAlts, with their associated priorities and schedules. It is anticipated that the majority of alterations identified during the Development Phase will be scheduled for performance either during the pre-EOC overhaul or during an early EOC availability if there is no requirement for a pre-EOC overhaul.

The comprehensive, prioritized list of required alterations is then sent to the TYCOMs and applicable NAVSEA codes for review and approval with a request that the alterations be scheduled and funded in the FMP (Title K ShipAlts and OrdAlts) and in TYCOM alteration schedules (Title D ShipAlts) to support the EOC maintenance strategy. The alterations requirements forwarded to the TYCOMs and NAVSEA for funding and scheduling are an EOC program recommendation and should be documented with enough supporting information to give them a good chance for approval as requested.

4.5 CRITICAL EQUIPMENT/SYSTEM IDENTIFICATION

The Critical Equipment/System List is prepared to ensure that an EOC program's maintenance engineering development efforts concentrate on those equipments or systems that have the most significant maintenance related problems. The list identifies, in priority order, the candidates for engineering attention. The efforts must support the preparation of:

- In-depth engineering maintenance analyses of systems, equipments, and components
- Identification of required Technical Repair Standards
- Identification of probable Material Condition Assessment procedures
- Identification of repair requirements for the pre-EOC overhaul

The general approach to the development of a Critical Equipment/System List is to establish criticality criteria, gather maintenance-related data, and analyze and summarize the data. The following sections briefly describe each of the steps and provide guidance for their accomplishment.

4.5.1 Establishment of Criticality Criteria

The criticality criteria for the systems and equipments on the list must be based on the EOC program objectives and constraints. To set such criteria, measures are established that quantify the ship class maintenance

problems in appropriate terms. For example, if the objectives and constraints are increased availability and reduced cost, the criticality criteria must be in terms of availability (time) and dollars.

4.5.2 Gathering of Maintenance Related Data

As stated in Chapter Three, the type of data required is dictated by the EOC program objectives and constraints and the analyses to be performed. The sources of data, however, depend on the extent of operational history of the ship class. The types of data required for development of the Critical Equipment/System List likewise are dictated by the previously established criticality criteria that, in turn, are based on the EOC program objectives and constraints. Similarly, the cautions in Chapter Three related to data characteristics also apply. Therefore, to the extent specified in the program objectives and constraints, data must be identified, selected, and collected to determine the equipment and system criticality. Actual ship class historical data are preferred for this study. If, however, the operational history is insufficient to provide the necessary data, ship class design data may be analyzed instead. Appendix C suggests data sources.

4.5.3 Data Summary and Analysis

The data should be summarized and transformed into terms compatible with the previously established criticality criteria. Algorithms are therefore developed which convert the historical or prediction data into the desired terms and perform the necessary calculations. The resulting values are sorted by ship system and equipment, then ranked in order of criticality. The resulting list may be used to select the systems and equipment for detailed engineering analysis. Appendix G provides guidance for selection of candidates for repairable change-out equipment screening from the Critical Equipment/System list.

4.6 REFINEMENT OF ENGINEERING ANALYSIS REQUIREMENTS

On the basis of ShipAlts and OrdAlts recommended for the EOC program, the critical equipments and systems identified as high priority maintenance problems, and the type and form of data available, requirements for engineering analysis are carefully refined. Previous estimates for equipment and system analyses are changed to reflect the findings of these preparatory studies.

The Critical Equipment/System List is compared with the Alteration List to determine the extent of changes to be made to the problem equipment and systems. If the effect of the alteration on the operation of the system cannot be readily determined, the extent of anticipated configuration change is noted for use during the engineering analyses. When a sufficient number of related equipments are identified as having significant maintenance problems, they are grouped into a system and the system (instead of the individual equipments) is identified for analysis. The criticality of

each equipment and system as reconfigured is then reestimated and the ranking revised accordingly. From the type and form of the available data, specific analytical and engineering techniques are identified for the performance of the engineering analyses.

Resources required to analyze the most critical systems are estimated. On the basis of these estimates, available resources are allocated to systems that will benefit most from engineering analysis. A schedule of engineering analyses by system is then prepared projecting resources and methods. This schedule is used to manage the engineering analysis phase of the EOC program.

4.7 SYSTEM ENGINEERING ANALYSIS

The equipment and systems identified in the Critical Equipment/System List, as modified during the refinement of the System Engineering Analysis process, are analyzed to establish a maintenance policy and maintenance standards; identify overhaul requirements, ILS requirements, and potential MCA requirements; and to identify and develop PMS change requirements. These analyses are referred to as System Engineering Analyses (SEAs).

The SEA for selected ship systems develops a comprehensive definition of known and potential problems that will have an EOC impact, determines an economical and effective maintenance program for solving these problems, and reports these findings in a format compatible with other EOC program documents.

The SEA process is described in detail in Appendix F. Essentially it consists of specifically defining the system to be analyzed, identifying and classifying problems that will affect the EOC, and selecting appropriate cost-effective maintenance program solutions. This process will result in Integrated Logistic Support changes, PMS changes, overhaul requirements, and inputs to other EOC program documents (e.g., CMP and Overhaul Analysis Program). Appendix G details a specific analytical technique for repairable change-out equipment identification, which may be utilized as a portion of the overall SEA.

4.8 DEVELOPMENT OF PRE-EOC OVERHAUL REQUIREMENTS

If a pre-EOC overhaul has been deemed necessary to return the ship class to an acceptable material condition before its entry into an EOC, the overhaul repair requirements should be identified and documented for planning purposes. The overhaul repair requirements also provide a basis from which to estimate the resources that will be required to perform the pre-EOC overhaul, including an accurate estimate of labor man-days and material expenditure, long-lead-time materials (LLTM), special tools, skills, and facilities.

The repair requirements include the repair and alteration requirements, the repair standards, and the post-overhaul test and certification require-

ments common to the entire class essential for the reliable and sustained operation of a ship during the Engineered Operating Cycle.

The pre-EOC overhaul requirements are prepared from a combination of the results of the most current system engineering analyses and previous overhaul experience. Because of the time constraints on the development of an EOC program, pre-EOC overhaul requirements may have to be prepared before all engineering analyses are completed. Until those analyses are completed, the pre-EOC overhaul requirements must depend on the best available data and information. As analyses for systems or equipments are completed, the overhaul repair requirements should be revised to incorporate analyses findings. Ideally all system engineering analyses will be completed before development of the pre-EOC overhaul requirements or initiation of the first pre-EOC overhaul.

The following sections briefly describe each of the steps to the development and updating of the pre-EOC overhaul requirements and provide guidance for their accomplishment.

4.8.1 Identification of Ship Class Systems and Major Equipments

The ship class systems and major equipments should be identified to ensure that the overhaul requirements adequately cover the entire ship. A configuration accounting system that logically divides the ship should be used. The two most common systems used by depot facilities are Ship Work Breakdown Structure (SWBS) and Ship Work Authorization Boundary System (SWABS).

4.8.2 Identification of Data Pertinent to Material Condition and Required Repairs

Data pertinent to the specific required repairs for a ship class or the achievement of a minimum material condition should be reviewed. The following is a discussion of some of the data that can be used in the identification of the overhaul repair requirements.

4.8.2.1 Engineering Analyses

Mandatory overhaul work that has been identified by detailed equipment or system engineering analyses should be included in the overhaul repair requirements. This includes not only the results of the engineering analyses being conducted in the EOC program, but also the analyses conducted by other activities (e.g., NAVELEX, NAVSEC, the ordnance community). This requires a thorough investigation of all ship program areas to determine what analyses have been made.

4.8.2.2 Pre-Overhaul Test and Inspection

The POT&I is performed to determine overhaul work requirements. It is necessary for some equipment to undergo a test in order for technicians to determine its repair requirements. POT&I should be limited to equipments

or systems for which tests will yield significant and not otherwise available information for determining overhaul work requirements. A POT&I should be scheduled before the pre-EOC overhaul and the results incorporated in the pre-EOC overhaul requirements.

4.8.2.3 1200-psi Propulsion Plant Improvement Program Requirements

PMS 301, through various maintenance history analyses of ship classes with 1200-psi propulsion plants, identified minimum overhaul refurbishments for certain equipments to ensure safe and reliable operation. Because of the similarities of 1200-psi propulsion plant designs and their maintenance experience, it can be assumed that these mandatory overhaul requirements would be necessary for all 1200-psi propulsion ships.

4.8.2.4 Class INSURV Discrepancies

The Board of Inspection and Survey conducts a series of Underway Material Inspections of classes of ships to provide a basis for assessment of the material condition of the ships in the class. Repairs required to correct the class material discrepancies identified in the inspection report should be included in class overhaul repair requirements.

4.8.2.5 Critical Equipments

The class Critical Equipment/System List is developed through an analysis conducted to identify equipments and systems that significantly affect the ship's capability to fulfill the objectives of the EOC program. Because these equipments may limit the success of the EOC, it is necessary that they be in satisfactory material condition upon entering the Engineered Operating Cycle. Therefore, the class common repairs for these equipments should be identified and included in the overhaul repair requirements. Appendix G sets forth guidance for selecting candidate equipments for screening as repairable change-out items from the Critical Equipment/ System List.

4.8.3 Collection of Requirements into a Single Document

All overhaul repair requirements that have been identified from repair profiles, SARPs, Alteration Lists, INSURV discrepancies, etc., should be collected into a single document. Two considerations should guide the compilation process: It should contain only repairs or refurbishments that can be analytically predicted or historically justified; it should contain only specific actions that can be defined well enough to permit the preparation of depot job orders.

4.8.4 Definition of Repair, Test, and Certification Requirements

After the repair requirements have been listed, it is necessary to specify standards and procedures by which these repairs are to be accomplished. Specifications found in Technical Repair Standards, alteration

specifications, 1200-psi Propulsion Plant Improvement Program requirements, technical manuals, etc., should be identified for repair requirements on an individual case basis as is cost-effective. The repair requirements that will require test and certification upon completion of the repairs to demonstrate that specific ship systems and equipments operate at acceptable levels of performance should also be identified. Existing TRS and T&C documentation should be used to define the repair requirements. However, where cost-effective, new TRS and T&C documentation preparation should be funded by the EOC program from the monies allocated for development of EOC planning and engineering requirements.

At this point the pre-EOC overhaul repair requirements document should contain the repair requirements, standards and procedures by which requirements are to be accomplished, and identification of testing and certification requirements. It should be prepared in a format that is readily usable by an overhaul planning activity. Organizing the requirements in a familiar sequence such as SWBS or SWABS order is also recommended.

4.8.5 Identification of Resource and Material Requirements

The resources and material required to support the repair requirements should be identified. Resource requirements data are available from SARPs, departure reports, Maintenance Engineering Analyses (MEAs), and other sources identified in Appendix C. In some cases, data regarding comparable or similar equipment or systems in other ship classes may be the only available information.

Material (especially Long-Lead-Time Material -- LLTM) should be identified and scheduled in order to support the pre-EOC overhaul requirements. Once LLTM has been identified, it must be procured and its status should be continuously monitored to assure its availability in a timely manner to support the overhaul schedule. The EOC Program Office should identify the responsible activity for each of these functions. Non-LLTM may be procured, scheduled, and its status monitored by normal overhaul planning procedures.

4.8.6 Updating of Overhaul Repair Requirements

The initial list of overhaul repair requirements includes some mandatory and high probability repair items that are not the results of detailed engineering analyses. Ultimately, however, it is the goal of an EOC program to have overhaul repair requirements reflect only the mandatory repairs rigorously justified by the EOC program, SEAs, other analyses conducted by outside activities, etc. This should be achieved by adding, deleting, or changing equipment overhaul requirements in the list of overhaul repair requirements as the results of detailed engineering analyses become available.

4.9 DEVELOPMENT OF THE CLASS MAINTENANCE PLAN

The purpose of the Class Maintenance Plan (CMP) is to provide the EOC maintenance requirements of a typical ship, to project the associated

resource requirements over time, and to provide guidance in the management of the maintenance.

The CMP specifies predictable maintenance tasks and their probable frequency, provides a summary of the associated resources necessary to maintain a ship class throughout its Engineered Operating Cycle, and explains management relationships and responsibilities during CMP execution. Additionally, IMA and depot-level maintenance requirements documented by sources other than EOC analyses are included in the CMP. Including these items is necessary to provide a single source which documents the total IMA and depot-level maintenance philosophy for any given equipment or system.

The CMP is a synthesis of information from various sources, including the technical community. In order to assure the completeness of information, the major ship systems and equipments are listed. Various sources of repair requirements are then researched and the requirements compiled against the system and equipment list. The sources include SEAs, repair profiles, SARPs, departure reports, etc. The repair list is then compared to the Critical Equipment/System List to identify unexplained omissions of repair requirements for previously identified problem systems or equipment. In addition, the repair list is reviewed for omissions on the basis of experience of the technical community. Where unexplained omissions are found, estimates or reservations should be substituted on the basis of the best available data or on the experience of the technical community.

4.9.1 Preparation of the CMP

The first step in preparing a CMP is the determination of the equipments and components of a typical ship of the class. Configuration documents are the COSAL, SECAS, and Weapon System File. In order to develop the CMP intelligently, an understanding of the design of systems and subsystems is necessary. Information in the Ship's Information Book and the ship's drawings can provide the required information. Since it is the configuration of the ship following its entry into an EOC that is of interest, it is necessary to update the configuration information with the Alteration List information.

A convenient way of organizing the CMP is by Ship's Work Breakdown Structure. The SWBS describes all functional components of a ship in a logical manner, system by system. It provides a convenient frame on which to systematically match component data from the COSAL, SECAS, and Weapon System File against physical configuration data from the SIB and drawings and with the associated repair requirements to be identified.

In addition to a repair description, there are certain other data elements that are part of a repair requirement. Since some data are hard to obtain and subject to uncertainty, consideration must be given to expected benefits in comparison with the effort expended and the uncertainty

in the results. A standard CMP format is under development which requires the following data elements:

- Related repairs that may be coincident with or alternative to the subject repair
- Special facilities required, such as crane or drydock
- Level of repair
- Man-hours required to perform the repair
- Repair frequency

Theoretically, the range of task descriptions and frequencies can range from the one extreme of running everything to failure to performing maintenance with a prohibitively expensive frequency that would eliminate almost all failures at the other extreme. As a practical matter, deciding what types of maintenance to perform, and when, will be derived from EOC program guidance setting forth the maintenance cycle, level of repair and repair philosophy (piece-part repair, rotatable pool, etc.), the importance of performing restorative maintenance before failure, etc.

It is therefore necessary to limit the types of maintenance to be included in the CMP. Considerations to be taken into account when deciding this include the cost of the repair, predictability of the maintenance, and whether it is separately formally documented and justified. Sufficient justification for a maintenance task may be an engineering analysis, sufficiently authoritative sources, or an analysis of historical maintenance data.

Repair requirements are collected from various sources such as SEAs, SARPs, repair profiles, departure reports, MEAs, and LSAs. These, in turn, are listed with the equipment and systems to which they apply. Since the CMP is primarily a synthesis of other analyses and requirements, the source of each repair requirement in it should be documented. Similarly, changes to the CMP should be documented. The documentation process need not be formal; in many cases a notation of the task source and any assumptions would be sufficient.

This list of repair requirements is then compared with other data sources that identify problem systems and equipment to detect any unexplained omissions of any previously identified repair requirements for equipments or systems. These sources could include the Critical Equipment/System List, CASREP summary reports, MDS summary reports, etc. These sources should be reviewed to identify systems and equipment that have received proportionally large amounts of maintenance or have high CASREP rates, have consistently appeared in SARPs or in SFOMs, are consistently listed on requirements for maintenance listed in Type Commanders Instructions or in requirements listed in the NSTM, or are required on the basis of the personal experience of the analyst. Amplifying details are often obtained from engineering analysis and from consultation with equipment manufacturers and cognizant Navy technical personnel.

The list of repairs should also be reviewed for omissions by representatives of the technical community with experience in the maintenance of the same or similar equipment. Reasons for omissions may be valid. For example, alterations to resolve the problem may have been performed or may be scheduled for performance. For maintenance requirements discovered by this review, the repair and resource requirements should be estimated. The estimates may have to be based on like equipment in the class or on similar equipment in other ship classes. Where estimates are not practical, reservations can be stipulated and details provided at a later date as more information is acquired and developed.

If appropriate details cannot be identified, it must be determined whether non-specific descriptions (i.e., Class "C" overhaul) should be included in the CMP. The same decision applies to man-hours reserved for particular groups of equipments or for alterations on the basis of historical maintenance data or predictions.

Within the CMP, the repair requirements may be divided into two categories: well defined actions at a predictable frequency and stated level of repair (IMA or Depot), and maintenance actions of uncertain description or frequency. This dichotomy ensures that those specific tasks that can be predicted are explicitly covered and described so they can drive individual ship maintenance plans. Inclusion of the less specific actions permits planning for the overall manpower requirements for the general skills required.

When all of the repair requirements have been developed, resource summaries can be prepared to show repair sequences and resource requirements over time, in accordance with the planned maintenance cycle. It may be necessary to adjust repair frequencies in order to match projected maintenance periods. These summaries can then be used to check the plan for reasonableness in comparison with historical data and for feasibility in relation to available resources.

4.9.2 Updating the CMP

Development of the CMP is an iterative process. In its early stages it may be considered tentative and a test of EOC feasibility. Engineering analysis will probably not be completely available. Upon completion of each iteration it may be desirable for the Type Commander and interested technical codes to review the CMP. Their comments should be used to improve task selection and description and resource requirements.

It is important that the sources for CMP maintenance requirements and changes to them be traceable to permit justifying the repairs and repair selections and showing that the CMP is based on sound premises and responsive to EOC program requirements.

In its final form the CMP must be able to provide input to individual ship maintenance plans. It must also be in a form in which it can be updated throughout the EOC in response to experience and configuration changes.

This requires that careful thought be given to the physical layout of the CMP and suggests that a computerized data base may be desirable.

4.10 EOC MANAGEMENT PLAN DEVELOPMENT

The EOC Management Plan is designed to serve managers and other principals as a guide for the execution of the EOC program as well as provide information and serve as a reference tool for those not involved in the EOC program every day.

The comprehensive Management Plan should (1) describe the background and objectives of and constraints on program development, (2) delineate the authority and responsibilities of those associated with the EOC program, and (3) explain the interface of personnel of various commands in the execution of the EOC.

The Management Plan should be the one EOC document that displays the various segments of the program blended together to constitute a coordinated and integrated effort. By describing the entire effort and displaying how the various elements fit together, it provides the means for interested parties at all levels to gain an appreciation of the entire program and see how their duties and responsibilities affect the overall effort. An effective Management Plan will explain to all concerned with the program how their inputs contribute to the overall effort and should stimulate them to provide their inputs promptly and completely.

On a day-to-day basis, the principal users of the Plan will be middle level officials at the systems commands and PERA, and on the Fleet and Type Commander staffs. The plan should be developed in a form appropriate for senior level officials in OPNAV and DOD as well as for junior shipboard personnel. Because of that diverse audience, clarity of writing and avoidance of jargon are imperative.

EOC programs may require certain actions by staff members of Fleet Commanders or Type Commanders, even though the EOC Program Manager has no authority to task those personnel. Description of the tasks required of Fleet personnel in this document (along with direct liaison with the commands) is expected to result in the required action without a time-consuming chain-of-command approval.

4.10.1 Initial Development

The development of the EOC Management Plan should commence soon after approval of the Initiation Study so that guidance can be promulgated as soon as possible.

4.10.1.1 Functions, Assignments and Responsibilities (FAR) Charts

The logical starting point for the development of the EOC Management Plan is the drafting of the EOC Functions, Assignments and Responsibilities (FAR) charts describing the actions necessary to implement the program.

The effort to develop these charts will vary somewhat depending on how similar the emerging EOC program is to existing programs, allowing for the use or adaptation of previously developed procedures. The drafting of the FAR charts should take place either concurrently with or immediately subsequent to the drafting of the Program Charter. The personnel developing the FAR charts should anticipate a significant amount of liaison and coordination with the Program Manager, his principal assistant, and representatives of the various commands to be associated with the program.

Typically, the FAR charts will address actions required in three general categories: policy and headquarters support, availability planning, and operations level (see Appendix D). At the policy and headquarters support level the participants will probably be CNO, CNM, Fleet Commanders, COMNAVSEASYSCOM, and COMNAVSUPSYSCOM. The availability planning charts should describe the functions, assignments, and responsibilities of those concerned, including COMNAVSEASYSCOM, PERA, Type Commanders, Ship's Force, industrial activities, and NAVSUPSYSCOM. The operations level chart may be used to explain procedures for functions such as material condition assessment. While the initial drafts of the FAR charts are being reviewed, work should be initiated on the text of the Management Plan, building on the baseline of the FAR charts.

4.10.1.2 Management Information Systems

As part of the Management Plan or as a concurrent effort, a Management Information System (MIS) should be developed. The first step is the definition of data requirements. The definition process should include a review of data elements existing under current maintenance policies and evaluation of data elements identified as being required during the initiation studies, a review of data requirements found to be essential or useful in other EOC programs and a determination of their applicability to the EOC under development, a review of 3-M requirements, and a review of SARP requirements. When the initial MIS data requirements have been determined, they should be examined to determine the type of MIS required. That may vary from a simple list or diagram to a complex data base manipulated by a computer program. In the development of a new EOC program, some data elements may be required only for a transition period. Because of the variety of data required at various phases, it may not be practical to develop one MIS to handle all the data requirements; simple requirements may be managed by a simple manual method while more complex continuing requirements may require sophisticated computer programs.

Existing data systems should be examined to determine their applicability to the EOC program and to determine interface requirements. It is likely that maintenance planning data requirements will need an interface with the existing 3-M, SARP planning, and IMA data processing systems. It is important to examine MISs in use for other EOC programs to determine whether they can be modified to suit the needs of the EOC program under development. Normally, it will cost far less in time and money to modify existing programs with proven interface capabilities than to develop new programs. When an MIS has been selected, the activity to be responsible for it, such as the EOC Program Manager, PERA, Fleet Commanders, or a contractor, should be determined.

4.10.2 Final Development

The texts of Management Plans for individual EOC programs may vary significantly, but each should normally discuss, as a minimum, six basic topics:

- EOC Program Overview
- EOC Program Functions, Assignments and Responsibilities
- Program Organizational Structure
- Program Material Condition Assessment Procedures
- Program Maintenance and Supply Management
- Program Resource Management

Additional topics such as Automatic Data Processing (ADP) Systems, Class Maintenance Plan, and Work Package Planning may be desirable or necessary for clarity.

4.10.2.1 EOC Program Overview

An overview is normally necessary to set the scene for the subsequent topics, which address major components of the program in greater detail. The overview usually includes the program background, objectives, constraints, and relationships. The background section should describe the evolution of the program, list the ship classes to be encompassed, identify the organization in which the Program Office is located, and describe (verbally or graphically) the Engineered Operating Cycle schedule for phasing in of EOC ships.

Program objectives should clearly define the program aims as currently approved by CNO or other authority.

Program constraints should address the parameters which limit the development of the program, e.g., cycle length, costs, percent of availability time, or deployments per cycle.

This section may discuss the segments of the Washington community that directly affect the program, e.g., overall direction within OPNAV, OPNAV program sponsor, NAVSEA directorates, applicable PMS codes, and the EOC Program Manager. A brief description of the EOC responsibilities of each office should be provided. Any special features of this EOC program should be highlighted in the overview, particularly if they depart from normal practices.

4.10.2.2 EOC Functions, Assignments and Responsibities

The EOC Program Functions, Assignments and Responsibilities (FAR) will typically describe the maintenance philosophy and pre-conditions for ships entering EOC, and identify condition assessment teams (as applicable) and special technical or support groups required to support program objectives (see Appendix D).

The matrices describing the FAR for the program describe the baseline for the program. Their number and complexity will vary among EOC programs. Typically, an EOC FAR matrix for policy and headquarters support will reflect the basic functions of CNO, Fleet Commanders, COMNAVSEASYSCOM and COMNAVSUPSYSCOM. The availability planning matrix may include functions of NAVSEASYSCOM offices, PERA, Type Commander and special groups thereunder, involved ships, industrial activities and NAVSUPSYSCOM. Depending on the structure of the program, a matrix may be required to depict functions, assignments, and responsibilities at the operations level, especially if the program includes provisions for condition assessment, trend analysis, etc.

4.10.2.3 Program Organizational Structure

The Program Organizational Structure will normally consist of a description of the various offices of the commands involved in the EOC program, supplemented by functional diagrams depicting command relationships and information flow. Functional diagrams for activities may include personnel grade and specialty descriptions in addition to position titles where they are appropriate. In some instances there may be significant evolutionary changes in size and structure of the various offices associated with the EOC program, requiring a description of an initial and an ultimate organization or a sequential description of how the office or activity will evolve.

In general, those offices and activities that are line activities being expanded or assigned additional responsibilities may require relatively little description, whereas entirely unique activities and offices being created to perform new functions need their descriptions of responsibilities and functions defined in as precise detail as is feasible.

4.10.2.4 Program Material Condition Assessment Procedures

If the EOC Plan includes provisions for Material Condition Assessment, a discussion of the assessment procedures is generally provided. The discussion should address the various sources of assessment procedures, the preparation and review of procedures, methods for changing procedures, and integration of the procedures into the 3-M system. The duties and responsibilities of assessment personnel should be delineated even though the Program Manager cannot directly task them because of the nature of the command structure.

If the EOC Plan provides for special assessment teams, it should explain how the assessment team visits will be scheduled. The explanation should specify how many visits are anticipated per cycle and how the visits are to be coordinated and scheduled, and should discuss team procedures aboard ship and team reports to the various commands concerned.

4.10.2.5 Program Maintenance and Supply Management

This section describes how Program Maintenance and Supply Management

should be administered for the EOC program, with emphasis on major differences between the EOC procedures and previous systems.

A graphic display of a typical EOC, major events, and participants may be appropriate to show how the cycle will be scheduled. A typical figure would display the principal participants and key events affecting each over time. An example of this type of presentation appears as Figure 4-2.

Other events which should be addressed are Pre-Overhaul Test and Inspection, alteration requirements, SECAS validation, SOAP requirements, baseline validation, Class Maintenance Plan, ADP scheduled maintenance (if applicable), IMA availabilities, Selected Restricted Availabilities (if applicable), emergent availabilities, and regular overhauls. Other special features peculiar to the EOC program should also be addressed.

4.10.2.6 Program Resource Management

The start of any EOC program implies a change from the existing structure that will require a modification to Program Resource Management. Initial EOC funds and personnel authorization should have been provided for in the Program Objectives Memorandum (POM) preceding the Development Phase. That submission is normally a one-time event providing for funds that, in subsequent years, will be partially funded by the Program Office with the remainder to be funded by the Fleet/Type Commander. The Management Plan should clearly indicate which commands are to be responsible for funding of elements of the program. Provision should be included for field activities to submit their requirements for money and personnel to the proper claimant in a timely fashion to ensure that full program requirements are included in the annual POM process.

The Program Office may desire to receive reports on how field activities are expending EOC funds and man-days. If such reports are desired, their form and frequency should be specified.

Material support procedures, such as provisions for special test equipment and rotatable pool stocks, and other program support, such as engineering and analysis services, should be addressed, as applicable.

4.10.2.7 ADP Systems

If an ADP-based maintenance action scheduling system is to be implemented, like the submarine IMMP or the DDEOC RMMS, a description of the system in the management plan may be appropriate. It should describe major data inputs, their sources and frequencies, as well as outputs and their frequencies. The interfaces of the system with other ADP systems, such as SARP, SAMIS, and IMA, should be addressed. Illustrations may be appropriate to display what portions of the program are controlled by each activity, how interfaces are managed, and how the end products are derived.

4.10.2.8 Class Maintenance Plan

If the EOC program includes provision for a Class Maintenance Plan, the plan's development should be described. The description should list major considerations and factors excluded from the analysis. If, for example, the plan contains some "hard" requirements that must be performed at specific intervals and other "soft" maintenance actions that are included only as a possible requirement, the documentation should explain these differences and describe how they were derived. The approach and assumptions used to develop the plan should be presented, including the sources of information and specifications.

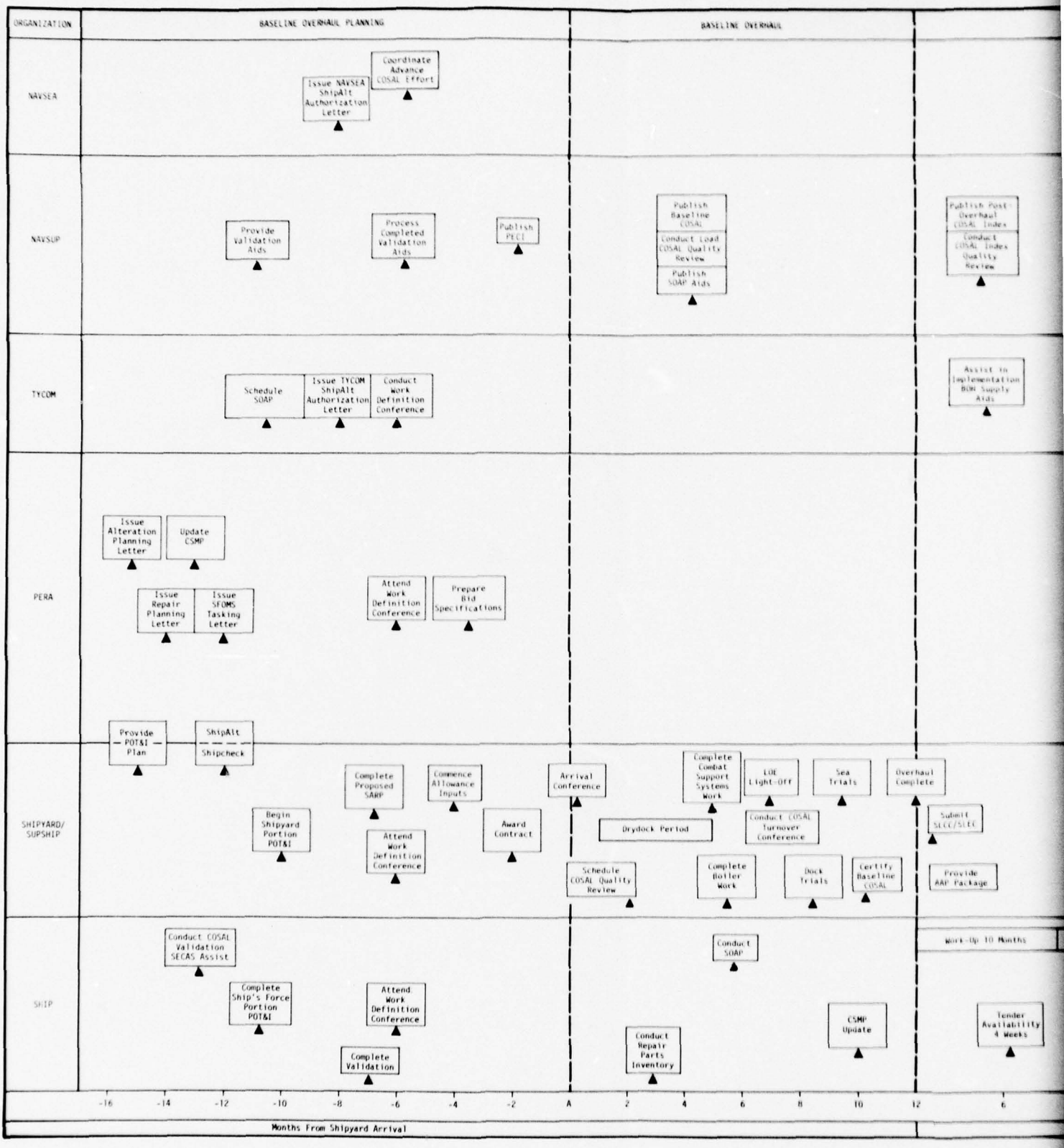
4.11 DEVELOPMENT OF MATERIAL CONDITION ASSESSMENT METHODS

An essential element of an EOC program that would improve material condition and operational availability is the development of effective means to assess the performance and material condition of selected ship systems or their components. The objectives of these assessments, which will be referred to as Material Condition Assessments (MCAs), are to determine present material condition and operational performance level and to provide data with which to recognize the approach of unacceptable material condition or performance levels, thereby forecasting the need for major corrective or restorative maintenance. After the practicality of MCA procedures has been determined by the SEA and the assessment parameters and values are established, the assessment procedures and assessment data analysis techniques that provide the optimum cost/benefit solution to the problem are developed.

The purpose of developing the Material Condition Assessment methods is to determine and document in a specified format the following information and procedures for the system or components identified by the SEA:

- Operational or material condition parameters which, if assessed periodically, would provide information required for the prevention of the system or component problem identified by the SEA
- For the parameters identified, the value levels that correspond to the best operation or material condition to be expected and the value levels that correspond to the minimum acceptable performance or condition
- If identified as necessary by the SEA, post-repair assessment criteria
- Detailed procedures to assess the performance and material condition of the system or its components identified for assessment by the SEA using the assessment parameters previously identified
- Analytical techniques to be used in evaluating the assessment data and monitoring performance and material condition trends

MCA methods consist of criteria and procedures invoked at the system level or at the component and equipment level. Wherever possible, system performance is measured to indicate material condition. Where system


ORGANIZATION
BASELINE OVERHAUL PLANNING
BASELINE OVERHAUL
NAVSEA
Coordinate Advance COSAL Effort
Issue NAVSEA ShipAlt Authorization Letter
NAVSUP
Provide Validation Aids
Process Completed Validation Aids
Publish PECI
Publish Baseline COSAL
Conduct Load COSAL Quality Review
Publish SOAP Aids
Publish Post-Overhaul COSAL Index
Conduct COSAL Index Quality Review
TYCOM
Schedule SOAP
Issue TYCOM ShipAlt Authorization Letter
Conduct Work Definition Conference
Assist in Implementation BOM Supply Aids
PERA
Issue Alteration Planning Letter
Update CSMP
Issue Repair Planning Letter
Issue SFOMS Tasking Letter
Attend Work Definition Conference
Prepare Bid Specifications
SHIPYARD/ SUPSHIP
Provide POT&I Plan
ShipAlt Shipcheck
Begin Shipyard Portion POT&I
Complete Proposed SARP
Attend Work Definition Conference
Commence Allowance Inputs
Award Contract
Arrival Conference
Schedule COSAL Quality Review
Drydock Period
Complete Combat Support Systems Work
Complete Boiler Work
LOE Light-Off
Conduct COSAL Turnover Conference
Sea Trials
Dock Trials
Overhaul Complete
Certify Baseline COSAL
Submit SLCC/SLEC
Provide AAP Package
SHIP
Conduct COSAL Validation SECAS Assist
Complete Ship's Force Portion POT&I
Attend Work Definition Conference
Complete Validation
Conduct SOAP
Conduct Repair Parts Inventory
CSMP Update
Work-Up 10 Months
Tender Availability 4 Weeks
-16
-14
-12
-10
-8
-6
-4
-2
A
2
4
6
8
10
12
6
Months From Shipyard Arrival

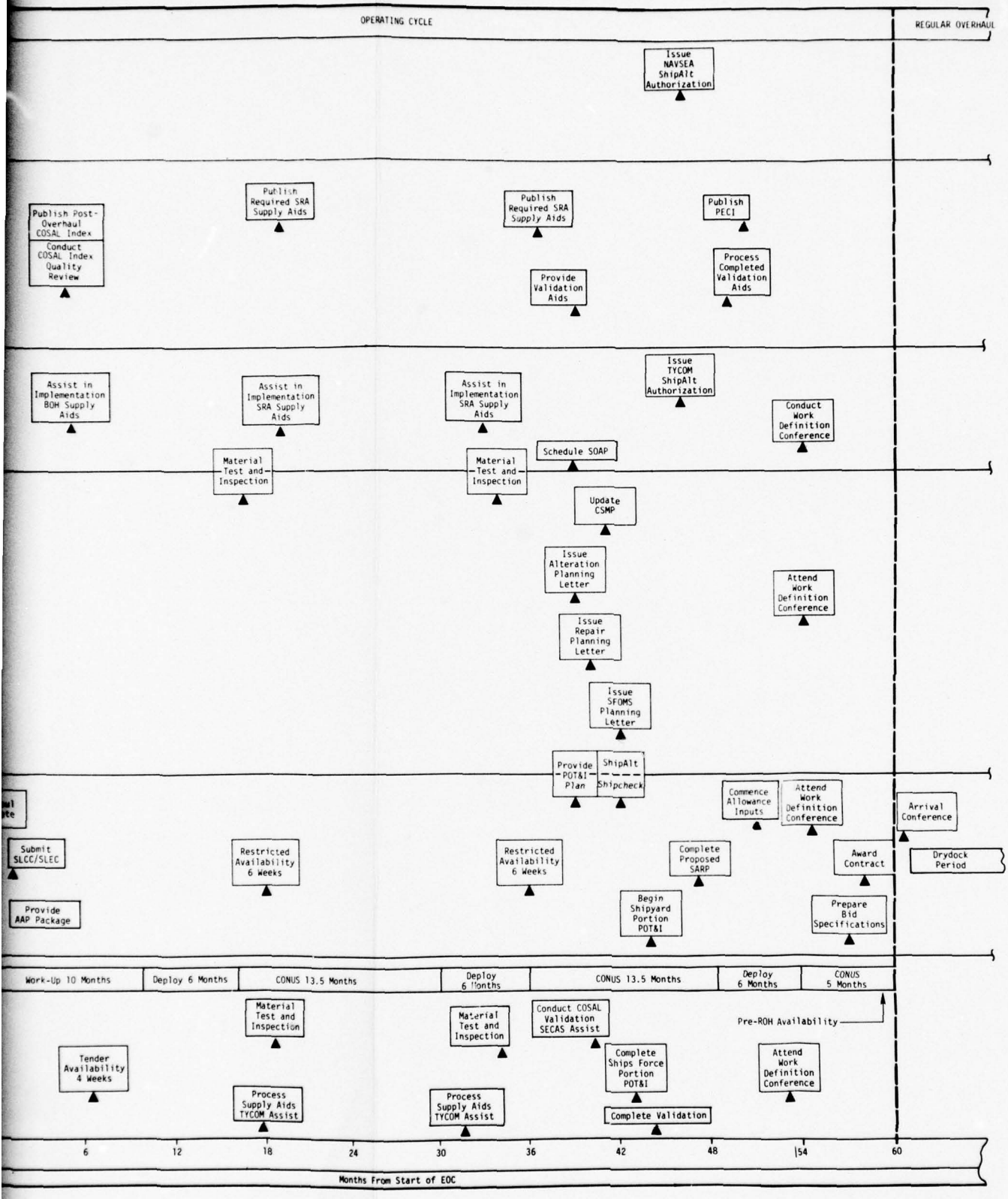


Figure 4-2. DDEOC ENGINEERED OPERATING CYCLE

2

performance does not give a valid indication of material condition, criteria and procedures are applied at the component and equipment level.

A detailed procedure for establishing MCA methods is described in Appendix H. The MCA criteria and procedures are established, in large part, on the basis of using existing information. MCA data are collected, parameters are identified, and upper and lower limits are selected. The MCA procedures are developed through a review of existing MCA information and existing procedures are used directly or modified, where feasible. When necessary, new procedures are prepared. The procedures are recorded on MRC cards for implementation by MCA Site Teams. A validation process may be invoked to determine the effectiveness of the MCA methods.

4.12 POST-OVERHAUL ANALYSIS PROGRAM

The Post-Overhaul Analysis Program is a logical consideration for those EOC programs whose maintenance strategy dictates a pre-EOC overhaul. Such an overhaul has been recommended for EOC programs that need to provide the class with an availability in which a minimum acceptable material condition could be attained by the performance of specific repairs or alterations before entry into the Engineered Operating Cycle.

The Post-Overhaul Analysis Program records the ship configuration changes and material condition on entering an EOC. This is accomplished by identifying the repairs and alterations performed during the overhaul, then comparing them to the pre-EOC overhaul requirements document to identify the deficiencies (i.e., repairs and alterations required but not accomplished).

The first step in establishing a Post-Overhaul Analysis Program is to identify the required data. The data to be used in this program are unique in that they have been generated totally during the Implementation Phase: pre-EOC overhaul repair and alteration requirements tailored to a particular ship and the repairs and alterations actually performed during the overhaul of that same ship. Table 4-1 identifies typical data sources for the Post-Overhaul Analysis Program.

Table 4-1. TYPICAL DATA SOURCES FOR THE EOC POST-OVERHAUL ANALYSIS PROGRAM

Source of Pre-Overhaul Data	Activity	Source of Post-Overhaul Data	Activity
Alteration List	Program Office	Test and Certification Data	Various
Other Scheduled Alterations	NAVSEA/TYCOM	Departure Reports	OH Act./ Indust. Act.
SARPS	PERA	SARP	PERA
SFOMS	Ship	CSMP	TYCOM
CSMP	TYCOM		

These suggested sources should provide the majority of the data required. To provide sufficient lead time for preparation and delivery, the respective activities should be notified early in the EOC program of the need and given a schedule for delivery of the data.

After all pre-overhaul data and post-overhaul data are collected, the information on the repair and alteration work actually accomplished must be compiled and the revised ship, system, and equipment configurations recorded. This same information must be compared to the repairs and alterations identified as required to achieve a satisfactory material condition for the particular ship under study, and an evaluation made and results recorded as to its material condition upon entering its EOC. Any deferred or otherwise uncompleted work must be rescheduled for accomplishment early in the EOC to permit certification that an acceptable level of material condition has been attained.

It is anticipated that development of the Post-Overhaul Analysis Program will be an iterative process. In conjunction with the Program Effectiveness Procedures discussed in Section 4.13, and after several post-overhaul analyses have been conducted on individual ships, trend analyses should be performed to evaluate the overall effectiveness of the pre-EOC overhaul requirements development and of the pre-EOC overhauls themselves. Improvements should be suggested for subsequent pre-EOC overhauls within the class, i.e., refined work packages, updated schedules, additional work specifications, etc. In addition, the effectiveness of the Post-Overhaul Analysis Program should be reviewed. Specific elements of the program to be considered include analysis effectiveness, adequacy of program procedures, and quality and utility of analyses outputs. By continually evaluating the outputs generated from each overhaul analysis, the Post-Overhaul Analysis Program will remain responsive to the objective of ensuring that ships of the class receive a comprehensive overhaul, where necessary, before EOC entry and enter the EOC in at least a minimum acceptable material condition.

4.13 PROGRAM EFFECTIVENESS PROCEDURE DEVELOPMENT

Program effectiveness should be determined for two reasons: (1) to document the program's value to the class, and (2) to identify successful methods that should be expanded and unsuccessful ones that should be eliminated or modified. The program effectiveness can be estimated during the development of the EOC program, then validated at some time when a ship class is well into the Implementation Phase and sufficient EOC historical data are available for analysis. Existing EOC program effectiveness procedures should be utilized where feasible.

The program effectiveness technique progresses through four basic steps: (1) define measures of effectiveness (MOE), (2) determine historical values of MOEs (if possible), (3) determine current values of MOEs during the program, and (4) compare historical and current values.

4.13.1 Definition of MOEs

Measures of effectiveness should relate to program goals, e.g., "improve material condition; maintain or increase operational availability and keep costs within budget". Since MOEs will be evaluated in the real world, they should be defined in terms of data currently available or very easy to obtain. Three examples of MOEs being considered for measuring the effectiveness of one EOC program are: (a) Average level of maintenance backlog found in the CSMP (relates to material condition), (b) average total downtime of equipments as found in MDS and CASREPs (relates to material condition and operational availability), and (c) overall ship availability. The initial definition of MOEs should not be considered unchangeable. Provisions should be made for refining MOE definitions on the basis of experience gained during initial phases of measurement.

4.13.2 Determination of Historical MOE Values

For most ship classes, historical data on maintenance activity exist. If possible, the MOEs should be evaluated over several years before EOC program initiation. This will give a baseline from which to measure change. Historical data can be compared to future data only if the rules and operating conditions under which they are collected are similar.

4.13.3 Determination of Current MOE Values

Initial values should be estimated as the EOC program is being developed. In addition, MOE values should be determined as ships enter the program. This gives an opportunity for testing the practicality of the MOEs and yields a starting point from which to monitor program progress. As the program continues, the MOEs should be periodically evaluated. Some measures for which data are routinely collected may be evaluated relatively often, perhaps once a quarter. Other measures may be evaluated much less frequently and still be useful as indications of program effectiveness. Measures which can be monitored frequently and related to specific systems can be used to provide feedback on maintenance strategies designed for those systems.

4.13.4 Comparison of Current and Historical Results

During development of the EOC, historical effectiveness should be compared with current estimates of effectiveness. If the EOC estimated effectiveness is equal to or greater than that previously predicted, changes would be required only to provide further improvement. If, however, the resulting calculations indicate a significant decrease in effectiveness, the causes should be identified and appropriate changes made in the EOC program.

For comparisons based on actual operational data of older ship classes, this step indicates the difference between the old and new (EOC) maintenance strategies. To be valid, however, the comparison must be based on data reported under similar rules and operating conditions. Measuring

the effectiveness of a large maintenance program cannot be done precisely. Therefore, large changes in results are necessary to justify strong statements about the difference between old and new maintenance strategies. Here too the resulting effectiveness dictates the changes to the EOC program; if the actual program effectiveness is equal to or greater than the predictions, changes are necessary only for further improvement; if, however, the actual program effectiveness is significantly less than that predicted, the cause must be identified and appropriate changes made to the EOC program.

4.14 EOC PLAN

The EOC Plan incorporates in one document the products of the Development Phase and allows for an orderly transition into the Implementation Phase of the EOC program. The Plan presents requirements for the Implementation Phase and establishes an EOC Program Implementation Phase Schedule. The combined documentation of the Development Phase is explained and incorporated as part of the EOC Plan.

To do this, the EOC Plan first identifies and refines the Implementation Phase requirements unique to a particular EOC program. These requirements would be for funds, changes in personnel numbers and training, facilities, logistics, assessment procedures, and maintenance philosophies. They are identified as a result of a thorough review of the requirements identified in Chapter Five and the requirements developed during the Development Phase in light of the EOC program objectives and constraints. An Implementation Phase schedule is then developed using the POA&M and Master Network of Appendix E.

The EOC Plan identifies the documents developed during the Development Phase that are to be used during the Implementation Phase. These documents include the Pre-EOC Overhaul Requirements, the Class Maintenance Plan, the Management Plan, System/Equipment Engineering Analyses, MCA Procedures, Program Effectiveness Procedures, and the Post-Overhaul Analysis Program. Copies of these documents are included as part of the EOC Plan along with a description of each document and its relationship to each of the other documents. With this information contained in one document, transition to the Implementation Phase is greatly facilitated.

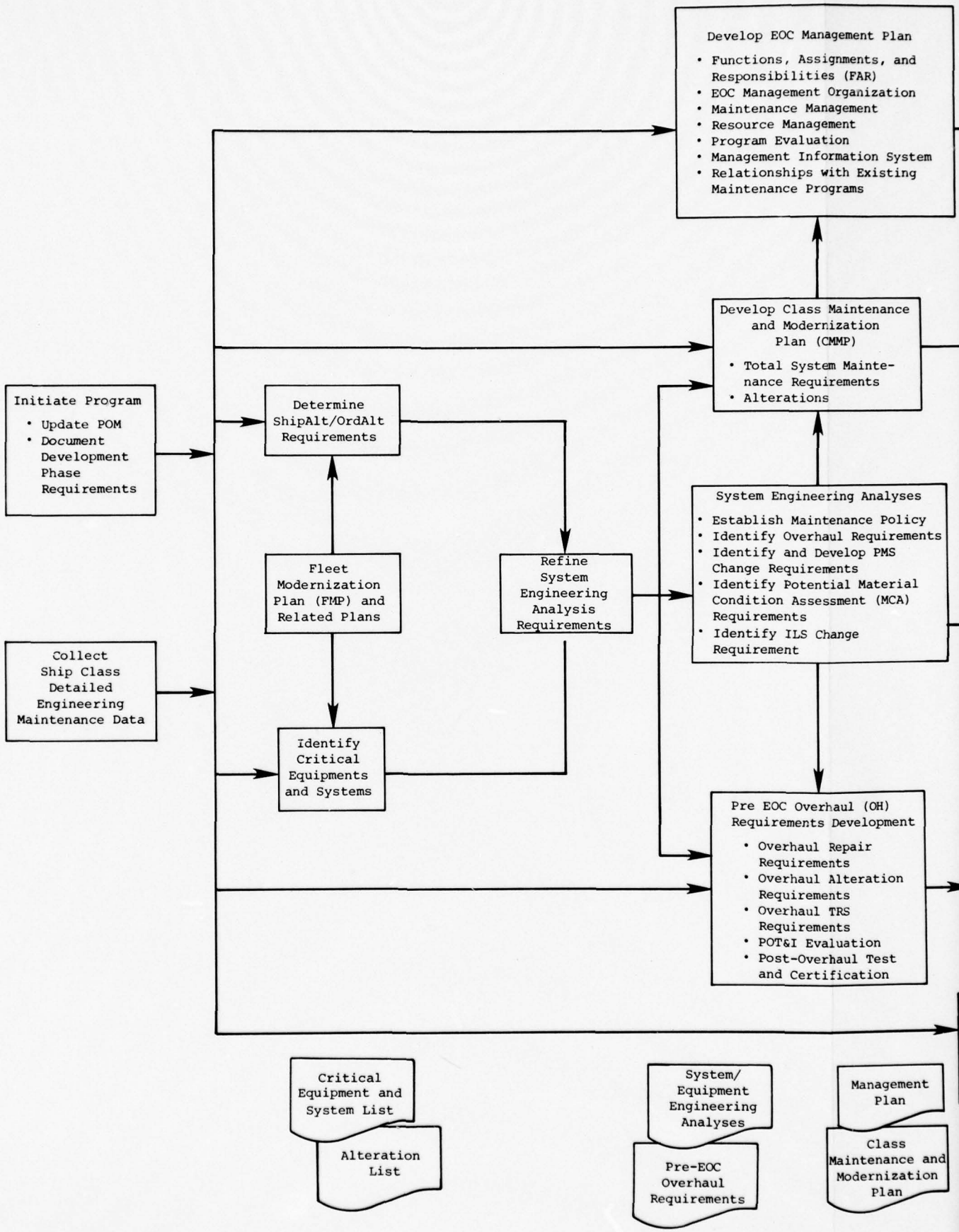
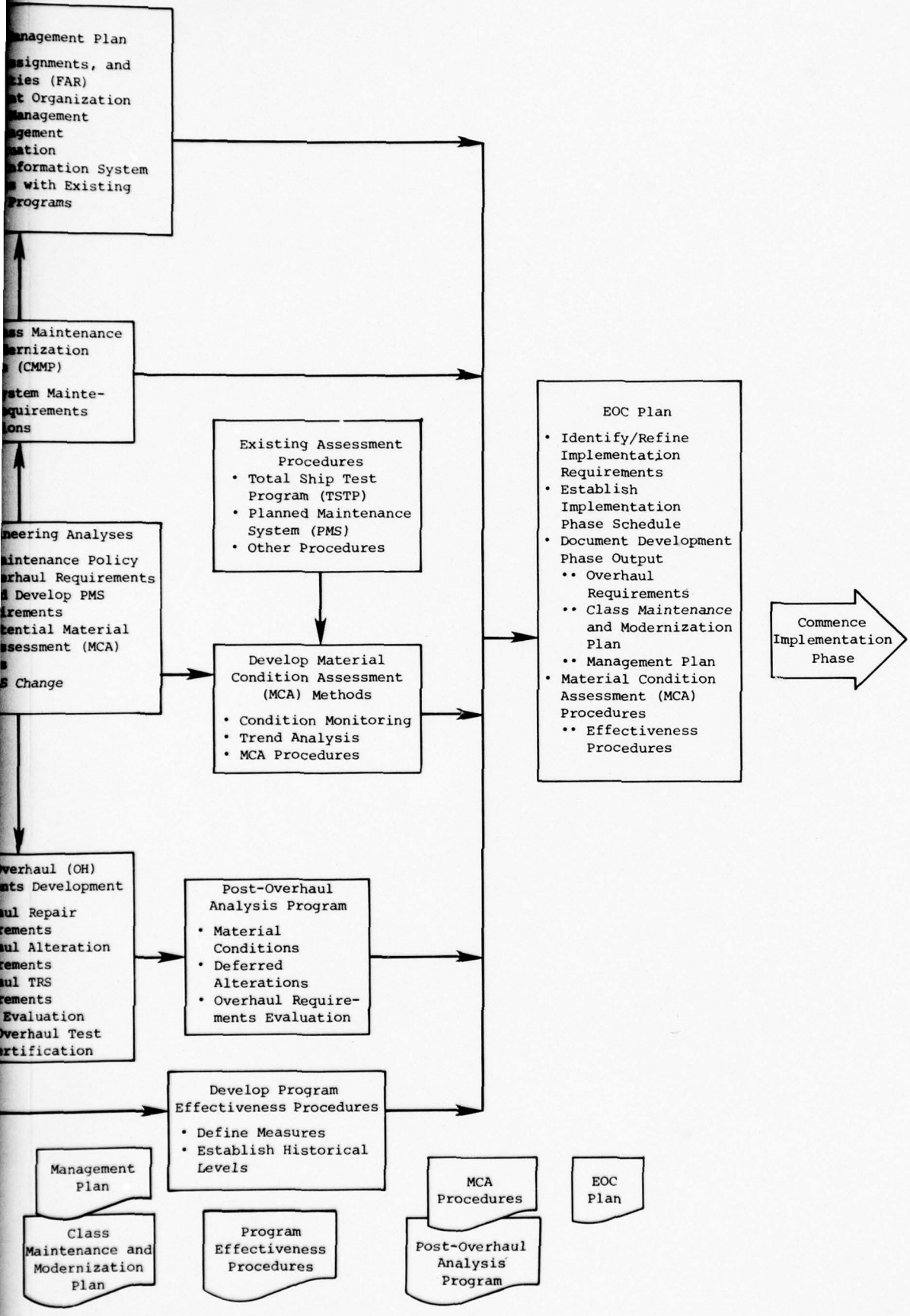


Figure 4-1. PROCESS DIAGRAM: EOC PROGRAM DEVELOPM



EOC PROGRAM DEVELOPMENT PHASE

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CHAPTER FIVE

IMPLEMENTATION PHASE

5.1 INTRODUCTION

This chapter describes the process by which an EOC program is implemented. It describes the efforts involved in staffing and training the EOC support organizations, accomplishing pre-EOC overhauls (when necessary), and adjusting the EOC program in accordance with implementation feedback results.

5.2 IMPLEMENTATION PHASE PROCESS

During the Implementation Phase the requirements contained in the EOC plan developed during the Development Phase are transformed into documents and procedures to prepare each ship for entry into the EOC. It is at this point that staffing and training of the EOC support organization must be completed and the groups integrated with other EOC programs, e.g., the Technical Group, the TYCOM Coordinators, and the EOC Site Teams. Figure 5-1 illustrates the process. (The figure has been placed at the end of the chapter as a fold-out page so it can be kept in view while the rest of the chapter is being read.)

Another major step requires the performance, where necessary, of pre-EOC overhauls. This involves the translation of the class overhaul requirements into a pre-EOC overhaul Work Package for each ship, the performance of the maintenance specified in the Work Package, followed by the entry of the ship into its Engineered Operating Cycle. In addition, the ship class maintenance plans are converted to individual ship maintenance plans.

The remainder of the Implementation Phase involves an iterative process (for each operating cycle) in which the ships proceeding through the EOC generate feedback information that results in adjustments to the EOC through Class Maintenance Plan changes and additional EOC engineering management procedures. The feedback information results from program effectiveness evaluations, material condition assessments, and post-overhaul, IMA, and trend analyses.

5.3 STAFFING AND INTEGRATION OF EOC SUPPORT ELEMENTS

In order to help ensure the effective and efficient management of an EOC program, several unique program support elements should be identified and established. The Program Office will have been established before the Implementation Phase begins. The EOC Technical Group, the Type Commander's Coordination Element, and the EOC site teams will remain to be established during the Implementation Phase and manned by government civilian and military personnel. Even though one of the four elements may have been established by the time the Implementation Phase begins, all four will require either complete or initial staffing. It should be anticipated that the personnel assigned to the various program support elements will be fully trained in their respective areas of assignment. It should also be anticipated that personnel new to the EOC program will require indoctrination in the objectives, operating procedures, interfaces, etc., of the EOC program relative to the other maintenance programs existing to support the selected ship class. An indoctrination/orientation presentation for new employees should therefore be developed early in the program if a NAVSEA indoctrination standard has not yet been developed and documented.

This EOC Program Development Manual addresses the development of a new EOC program, but such programs have already been developed for some classes or types of ship. Because some programs have been implemented with the same type of organization as the new program calls for, integration of the existing and the new EOC programs must be planned for early in each program. Ideally, by the time an EOC program has reached the Implementation Phase most of the major decisions having to do with program integration will already have been made, and all that remains will be to implement them in accordance with the provisions prescribed in the first two program phases. If those decisions have not been made, management decisions regarding such integration and logistic support areas as rotatable pools, manning of TYCOM program elements (i.e., Coordinators and Site Teams), and overhaul planning must be made immediately to facilitate program management.

5.4 PRE-EOC OVERHAUL

The pre-EOC overhaul is designed to raise a ship to an adequate level of material condition, sustainable during the ensuing operating interval as specified and refined during the first two program phases. This overhaul, prior to a ship's initial entry into an EOC program, may vary significantly from the overhauls it will receive later in its operating life. The pre-EOC overhaul, depending upon the material condition of the ships of the selected class and the objectives and constraints of the EOC program, can range from an extra-long overhaul, as in the DDEOC program baseline overhaul, to little or no overhaul if the ship is of recent construction. It is expected that most ship classes will have a pre-EOC overhaul. The pre-EOC overhaul will be planned in much the same manner as is currently done, except that the planning will receive a substantial EOC program input in

the area of recommended and required repairs that were documented during the Development Phase. The repairs are then incorporated into the overhaul Work Package for processing by the TYCOM and PERA.

At this time the CMP must be tailored to an individual ship. To tailor the CMP, the individual ship equipment configuration must be determined. The COSAL, SECAS, and the Weapon System File are the primary ship configuration documents.

The next step is to take from the CMP those maintenance tasks that are applicable to an individual ship, determine when they were last accomplished, and their frequency of accomplishment (as indicated in the CMP). The final step is to decide when next to schedule the various maintenance tasks; that schedule, coordinated with the ship's CSMP and PMS, is the individual ship maintenance plan.

5.5 ON-GOING EOC PROGRAM

Once a ship has completed its pre-EOC overhaul and has entered its Engineered Operating Cycle, it will have an individual ship's maintenance plan developed for it, based on the maintenance tasks contained in the Class Maintenance Plan, 3-M, Planned Maintenance System, and the ship's Current Ships Maintenance Project.

5.5.1 Ship's Process Through EOCs

As a ship proceeds through its Engineered Operating Cycles, maintenance tasks from its individual ship plan are performed and its individual ship plan is updated on the basis of the lessons learned from other EOC programs, other ships of the class, trend analysis of ship equipments, and tests and inspections performed on ship systems.

5.5.2 Program Feedback

Once the EOC program has been implemented in the Fleet, it will still require some changes to fine-tune the overall program to meet the maintenance needs of the selected class and to be able to respond to new or previously unidentified class problems. It is also to be expected that a few of the ideas that looked good on paper will not necessarily be practical on the ship. As these and other problems are identified from trend analyses, program effectiveness studies, material condition assessments, and the results of the overhaul analysis program, solutions will be developed. Those solutions will be provided to the Fleet via program feedback procedures and changes to existing maintenance plans.

5.5.3 Engineering Management of the EOC Program

Once an EOC program has been implemented, the engineering management must be flexible enough to be able to learn from both its successes and its failures, but it must also be rigid enough to ensure that the program

objectives are met. To that end, detailed program engineering management procedures beyond those contained in other program documents must be prepared and promulgated. In addition, feedback avenues need to be established by the Program Manager to update budget base and configuration information during EOC Implementation. This is particularly true if a new ship class for which no historical data exist is being integrated into an EOC program. For those ship equipments or systems which fail to receive required maintenance upgrades during the pre-EOC overhaul due to budget or material availability limitations, ROH review, feedback, and follow-up procedures should provide for accomplishment during subsequent SRA periods. Failure to include key improvements could jeopardize achieving and maintaining material readiness required for initial and subsequent extended overhaul cycles.

5.5.4 Class Maintenance Plan Modifications

As more and more ships of any one class complete their pre-EOC overhauls and enter their Engineered Operating Cycles, and as the tempo of EOC Site Team visits increases, it is anticipated that the existing CMP and other program maintenance documents will have to be modified. It is through these changes that the experience and information gained from engineering studies, the overhaul analysis program, material condition assessments, and the overall management of the EOC program are made available to all ships of the class.

5.5.5 Class Plans Translated to Individual Ship Plans

The feedback analysis information must also be incorporated into the individual ship maintenance plans, including the tailored CMP, the ship's PMS documents, and the ship's CSMP. In addition, as the ship progresses through the EOC, IMA, and depot availabilities, the individual class maintenance plans must be updated to report the scheduled maintenance that was performed and to reschedule the scheduled maintenance that was not performed.

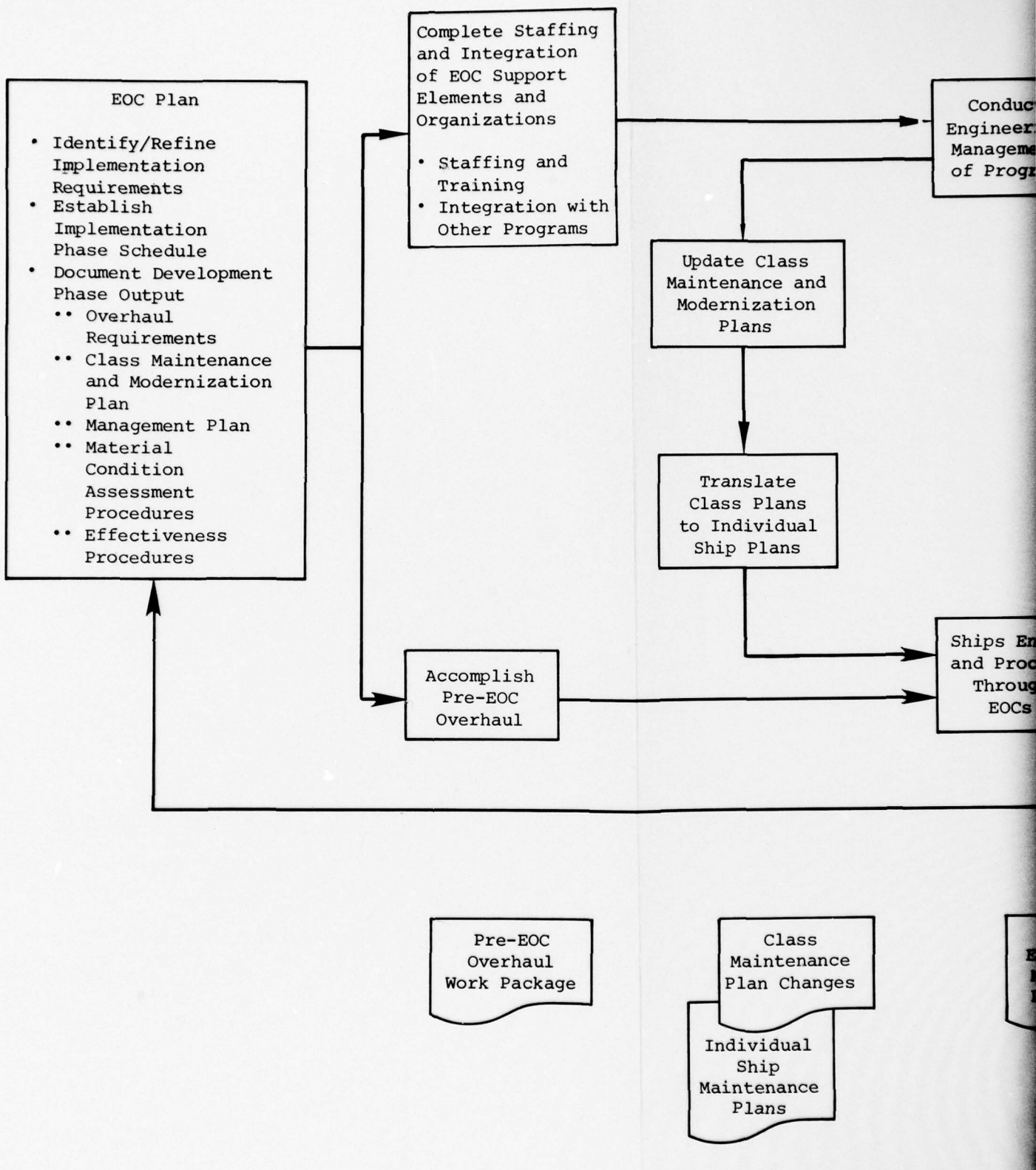
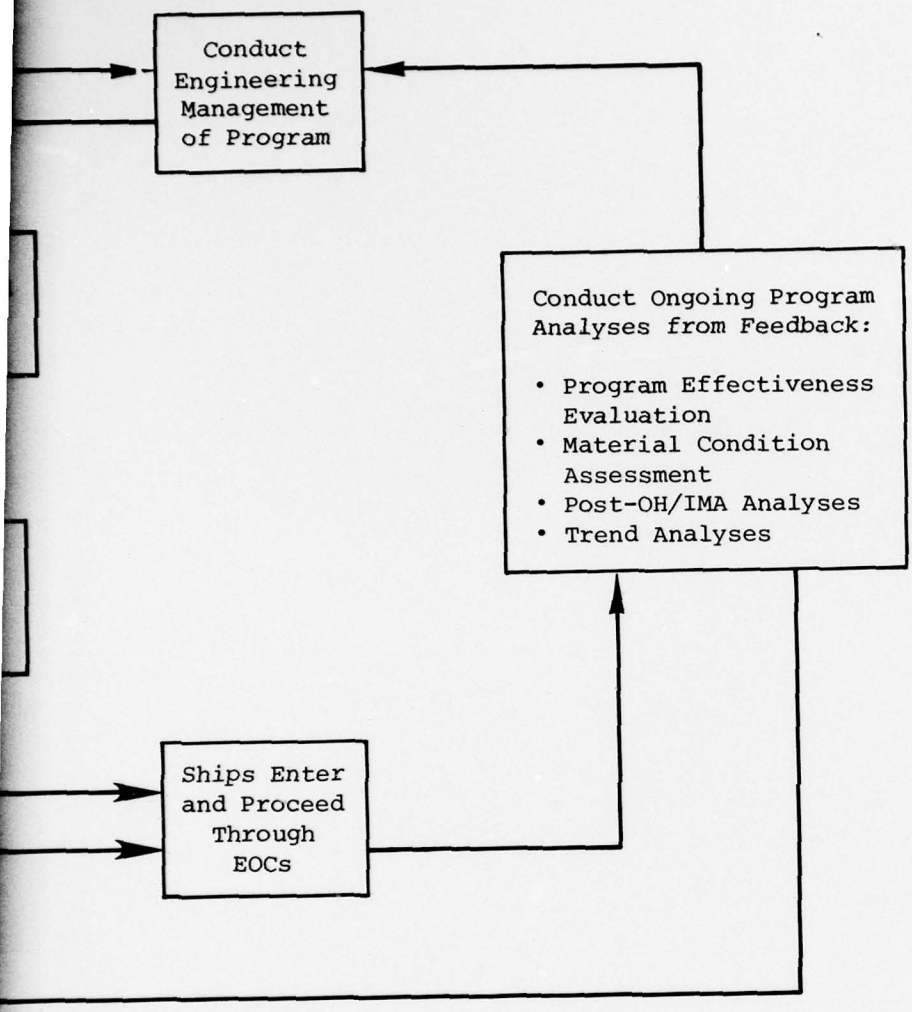


Figure 5-1. PROCESS DIAGRAM: EOC PROGRAM IMPLEMENTATION



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EOC Engineering Management Procedures

GRAM IMPLEMENTATION PHASE

2

CHAPTER SIX

MANAGING THE DEVELOPMENT OF AN EOC PROGRAM

6.1 INTRODUCTION

The EOC Program Manager is, by definition, breaking new ground by changing the methods by which the Navy maintains its ships. He coordinates the activities of a number of commands and maintains liaison with various levels of command in Headquarters, the Field, and the Fleet. The degree of success of the program will depend, in large part, on the ability of the manager to coordinate the efforts at various activities to ensure timely inputs for high level decisions.

The Program Manager will have to deal with such commands and activities as the following ones, listed with their areas of responsibility:

- CNO - Program objectives, constraints, and approval. Resources programming *FMP approval.*
- NAVMAT - Program objectives and approval. Coordination among NAVMAT offices.
- NAVSEA Headquarters - Program direction and supervision, funding, PMS coordination, IMA coordination, FMP coordination, depot level costing.
- NAVSEA Field Activities - IMA and depot level scheduling and coordination, automated maintenance scheduling systems. 3-M changes.
- NAVSEC (including field activities) - Engineering expertise in specific systems, engineering analyses.
- NAVSUP (including SPCC) - Repair parts inventory, rotatable pools, SOAP support, COSALs, PECIs, Validation Aids, APLs/AELs.
- PMS 306 - Funding, coordination of IMA support, rotatable pools logistic data management systems, rework facilities.
- Other EOC Managers - Sharing of lessons learned and common or shared assets.
- Fleet Commanders - Program coordination, operational constraints, overhaul and IMA funding.

- PERA - Assist NAVSEA Headquarters in identification and implementation of overhaul and maintenance planning requirements.
- Type Commanders - Program coordination and execution, operational constraints, funding constraints, training constraints.
- Ships and Unit Commanders - Equipment problems, training problems, assistance needs.
- Contractors - Engineering analyses and support.

6.2 EOC PROGRAM INITIATION

The first step confronting a Program Manager is the establishment of a staff and acquiring funds to perform the EOC Initiation Study. He requires a staff, office space, and O&MN funds for travel and studies. Personnel and funds ordinarily must come from previously programmed assets so that starting a new program will depend on the manager's ability to convincingly plan and program such that greater efficiencies are realized from use of existing Navy assets. Once he has acquired a staff and financial assets, the EOC Program Manager should start the Initiation Study. He has three basic options: it may be an in-house study, it may be performed by a government laboratory or engineering agency, or it may be performed by a private contractor. It is not necessary that the entire Initiation Study be done by one organization; the manager might assign the engineering analyses to a contractor while performing the cost analysis in-house. Such division of effort will normally increase the criticality of scheduling and coordination.

Early in the Initiation Phase the manager will receive guidance regarding objectives such as material *readiness, operational availability,* etc. To the degree that it is feasible, the Program Manager should avoid specific technical goals or precise program cost limits. Targeting the study to achieve very specific objectives may reduce its effectiveness when significant improvements in program results might be achieved from flexibility regarding goals.

When the Program Manager has in hand the results of the study, he should structure the inputs to the POM. Since the study presumably compared the EOC program with existing practices, the data to prepare a zero base budget submission should be available. Because the justification must be reviewed at several echelons of command and eventually emerge as a budget line item, the justification must be clear and convincing to immediate superiors, Office of the Secretary of Defense (OSD) staff personnel, budget analysts, and congressional staff personnel. As the program moves through the chain of command for approval, the Program Manager should keep track of it and prevent delays in its progress. Timely and effective liaison and coordination with the various echelons of command are necessary to ensure that appropriate assets for the project are included in the budget.

Typical activities associated with the Initiation Phase in which the EOC Program Manager would be involved include:

- Identifying EOC Initiation Study objectives and constraints

- Establishing a staff and acquiring funds for the study
- Providing direction, support, guidance, and coordination during the Initiation Study
- Providing coordination and liaison with other study-related Navy commands and offices
- Planning, developing, and structuring resource requirements for POM submittals
- Coordinating the EOC Initiation Study recommendations, EOC Program feasibility decisions, and gaining formal approval of the program

6.3 EOC PROGRAM DEVELOPMENT

Analysis in the Initiation Phase is directed toward assessing the feasibility of applying EOC concepts to a given class (or classes) of ships, evaluating alternative approaches, and estimating program costs. Broadly speaking, the Initiation Phase is oriented to scoping and evaluating general approaches to a program. In the Development Phase, emphasis shifts to the specific structuring of the program, i.e., an engineered approach to EOC development applying reliability-centered maintenance principles.

At the onset of the Development Phase, the project staff should expend a significant amount of effort in supervising the agencies and contractors involved. The Development Phase involves a series of engineering analyses, some concurrent and others sequential. The success of the efforts during this phase will depend, in large measure, on the ability of the Program Manager and his staff to direct, critique, validate, coordinate, and orchestrate the several efforts. The Program Manager (and his staff) must take the necessary actions to implement the changes required to convert from existing procedures to improved engineered approaches leading to a higher state of ship material readiness.

As described in Chapters Two and Four, system and equipment maintenance requirements for overhaul and during the interval between overhauls are determined during the Development Phase. Those requirements are in a Class Maintenance Plan. Also during this phase, the post-overhaul analysis program is structured, an EOC Management Plan is developed, and procedures are developed for determining program effectivess.

6.3.1 Development of Maintenance Requirements

During the course of the engineering analyses of the equipment and systems, progress should be monitored continually to ensure that the analyses are accurate and thorough and that the schedule is adhered to. The manager's staff should coordinate ship and activity visits by the engineering analysts examining the equipments or systems.

When the engineering analyses have been completed, they should be thoroughly reviewed by the Program Manager, his staff, and appropriate NAVSEA/NAVSEC engineers. Following the review, several actions normally should

be coordinated to incorporate the changes and recommendations contained in the report. Typical changes and recommendations and the corresponding coordination activities are given in Table 6-1.

Table 6-1. CHANGE COORDINATION ACTIVITIES

Recommendation	Coordination Activity
Establish Maintenance Policy	NAVSEA, TYCOM, CNO, PERA
PMS Changes	NAVSEA, TYCOM, NAVSEC
Identify Potential MCA Candidates	NAVSEA, TYCOM, PERA, NAVSEC
Establish Standards	NAVSEC, PERA, TYCOM
Identify ILS Change Requirements	NAVSUP, NAVSEA
Develop MCA Methods	NAVSEC, NAVSEA, TYCOM, PERA
Identify Repairable Change-Out Procedures	NAVSEA, PERA, NAVSEC, TYCOM, NAVSUP

The results of the equipment-system analyses depend equally on the quality of the engineering appraisal and the success of the Program Manager to coordinate and effect the changes necessary to achieve increased ship material readiness.

The equipment-system engineering analyses will identify candidates for material condition assessment. The Program Manager should assign responsibility for development of assessment procedures and their evaluation as to both engineering suitability and practicality of implementation in the Fleet. As a minimum the Manager should coordinate and direct, as appropriate, the development agent, TYCOM representatives, NAVSEA and NAVSEC personnel, and PERA representatives. Additionally, equipments lending themselves to a repairable change-out maintenance philosophy should be selected (see Appendix G).

6.3.2 Development of Class Maintenance Plan

The Class Maintenance Plan projects the total maintenance scenario (not including PMS) for a ship during an EOC and describes the type of maintenance required, at which level it should be performed, and how frequently. If the plan is to be an effective document it should represent more than an optimal engineered approach to maintenance; it should represent the best compromise between the engineered approach and the dictates of cost, fleet operations, supply support, and IMA and depot workload. A workable plan will reflect a blend of the objectives of the various commands concerned. The extent to which the CMP reflects a sound engineering approach depends, in large measure, on the negotiating success of the Program Manager and coordination among CNO, NAVSEA, NAVSUP, PERA, Fleet and Type Commanders.

The system-equipment engineering analyses also serve as a major input to the pre-EOC Overhaul Requirements effort designed to restore the ships of a class to an acceptable baseline level of material readiness at which, with engineered maintenance practices, they can be maintained at affordable costs. The Program Manager must review the soundness of the engineering approach, and completeness and affordability of the overhaul package. For purposes of programming overhaul funds the resulting document should be precise enough to permit the Fleet Commanders and CNO to submit their overhaul budget requests 1-1/2 years before the year in which the overhaul will commence. (The deadline for requests for FY 81 overhaul funding occurs in approximately mid-FY 79.)

6.3.3 Development of Post-Overhaul Analysis Program

Having determined the overhaul requirements to restore ships to an appropriate baseline state, the Program Manager should establish an analysis program to measure how well the program progresses toward its goal. There are a number of ways to measure the degree of success, e.g., percentage of equipments or systems overhauled to specific standards, percentage of alterations complete, or percentage of mission-essential systems overhauled.

6.3.4 EOC Management Plan Development

During the course of the Initiation Phase and the early portion of the Development Phase, numerous agreements may have been negotiated as to Functions, Assignments, and Responsibilities (FAR) among various commands and activities. Some of these FAR agreements may be formally documented in official correspondence while others may have been arranged informally. Further, agreements between the Program Office and individual activities are not necessarily apparent to other activities affected by the program.

As the procedures, assets, and relationships become firm, it is desirable to promulgate an official document describing the program, its goals, resources, procedures, and relationships with existing maintenance programs.

Because of the number of commands and activities involved, drafts of sections of the EOC Management Plan such as the FAR matrices and maintenance management and command relationships should be circulated for review and approval before the Plan is published as an official program document. As program changes and modifications occur it may be necessary to reissue the plan at intervals of six to nine months.

6.3.5 Development of Program Effectiveness Procedures

As the engineering analyses are being developed and program procedures are formalized, the Program Manager should develop procedures to assess the effectiveness of the EOC program.

The reasons for this are several:

- The Program Manager will want a yardstick by which to measure the effectiveness of his program so that he may add features to correct deficiencies and delete features that are not effective.
- Superiors in the chain of command and Fleet and Type Commanders may require proof that the EOC program is cost- and mission-effective.
- Program and budget analysts (at various levels) will demand program justification for budget submissions.

6.3.6 Development of EOC Class Plan

At the completion of the EOC Development Phase, the requirements and procedures resulting from the detailed engineering analyses conducted during the phase must be compiled into an EOC Class Plan. The Program Manager must develop and coordinate all engineering requirements into a composite plan which identifies and schedules the activities required to implement the EOC for the class of ships involved.

6.4 PROGRAM IMPLEMENTATION

As the program moves into the Implementation Phase, the Program Manager should review the entire program. As program elements (e.g., Site Teams, Technical Group) are activated, it is likely that feedback will suggest modification of procedures, manning, or funding.

As the first ships proceed through the EOC overhauls, experience may dictate modifications to the overhaul package. FMP plans should be reviewed to ensure that the modernization plans and the maintenance scenario are compatible. Personnel of the various elements of the EOC team will need to develop working relationships. The priorities for equipment-system analyses should probably be reviewed at this time. Requirements for personnel, material, and supply support may differ from those predicted and reprogramming or other changes may be required. The nature of the changes will be dictated by actual experience as the program is "fine tuned".

As the ships embark on EOCs, education of Fleet personnel becomes an important part of the program. During the planning and development phases interest will be centered in the Washington community, Fleet staffs, and PERA, because operating personnel are primarily concerned with near-term operations. Early education of shipboard personnel on the principle of EOC and how it will help them is essential to the enlistment of the cooperation and support necessary to make the program successful. Feedback and constructive criticism should be encouraged from all levels.

6.5 SUMMARY

Engineered Operating Cycle programs are significantly affecting how the Navy maintains its ships. Those programs have come into being because increased equipment complexity, rapidly escalating operating costs, and demands for higher ship operational availability have made it increasingly difficult to maintain satisfactory ship material condition. The EOC approach over the last decade, based on sound engineering judgment coupled with realistic maintenance management concepts, has been more evolutionary than revolutionary. That evolution of EOC programs has drawn upon a wide spectrum of experiences from diverse maintenance organizations such as those of the commercial airlines, other government agencies, and various elements of the Navy.

As EOC programs mature and more fully implement new concepts of reliability-centered maintenance, the Navy expects to achieve higher goals of ship material readiness at reasonable costs. New EOC programs are the means of advancing the state of the art of Navy maintenance management. Well managed EOC programs are expected to contribute significantly to the operational readiness of the Fleet.

APPENDIX A

EXISTING EOC PROGRAMS

1. INTRODUCTION

A total of 51 percent of the Navy's ships are expected to be in an Engineered Operating Cycle by 1984. Remaining ships are being investigated, on a class-by-class basis, to determine which should be placed in new EOC programs and when. Table A-1 identifies several categories of Engineered Operating Cycle programs and indicates that the initial focus has been on major classes of combatant ships. The following sections of this appendix describe sponsored ship EOC programs. Direct liaison with these programs may be useful to provide added insight and current developments.

Table A-1. CATEGORIES OF ENGINEERED OPERATING *CYCLE PROGRAMS*

Lo-Mix Program	New Programs
FFG-7 Class	DD-963
PHM-1 Class	
	Potential Programs
Destroyer Program	
FF-1052 Class	Carriers
DDG-37 Class	Cruisers
CG-16 Class	Destroyers
CG-26 Class	Frigates
DDG-2 Class	Amphibious
	Underway Replenishment
	Mine Countermeasures
Submarine Program	
	Remaining Ships
SSBN Classes	
SSN Classes	Auxiliaries
Trident	RDT&E Support

2. SUBMARINE PROGRAMS

2.1 SSBN Ship System Maintenance Monitoring and Support (SMMS) Program

The SSBN Ship System Maintenance Monitoring and Support (SMMS) Program was established at the direction of the CNO in November 1970. The initial program objectives were to conduct an experiment to determine the feasibility of extending the interval between shipyard overhauls for SSBN submarines to a time compatible with the new long-life reactor cores and to provide the necessary logistic support to ensure the credibility of the EOC. By conducting shipyard overhauls at the time of required core renewal, maximum cost-effectiveness could be realized with minimum expenditure of maintenance funds. In support of the SMMS objective, it was considered necessary to establish a means of continuously monitoring the material condition of EOC ships to ensure the safety of these ships and to maintain the reliability required to meet operational commitments.

To determine system material conditions, monitoring of four critical ship systems was started in August 1971 on three 627 Class SSBNs. An initial list of 68 systems to be investigated, exclusive of Strategic Systems Program Office and NAVSEA-08 cognizant systems, was compiled by a group of three experienced senior submarine officers and reviewed by COMSUBLANT for adequacy. Detailed investigations into these systems have been conducted to develop monitoring procedures, define major material problems and their effect on the EOC, and determine the overall maintenance burden being experienced by Forces Afloat.

Monitoring of the first systems began in August 1971 with implementation of SMMS monitoring and surveillance procedures on the USS JAMES MADISON (SSBN 627). The 3-M Maintenance Requirement Card (MRC) format was selected as the most efficient means for implementing SMMS procedures. To aid in the collection of data, a data recording form was made an integral part of the MRC.

An SMMS Site Team was also established in 1971 to perform the monitoring and data recording specified by SMMS procedures. The Site Team's contribution has been a significant factor in ensuring the repeatability of the data. An unanticipated benefit of the SMMS Site Team concept has been the development of system and equipment maintenance expertise at the deployed site since the Site Team members observe the same equipments on several ships.

Monitoring procedures are performed, with few exceptions, during the normal refit period. Data collected by the Site Team using the MRC forms are submitted to the SMMS Office (SMMSO) at the end of each refit period. The frequency of monitoring each system or component varies from quarterly to once each four or five years.

Through continuous assessment of the ship systems' material condition, necessary corrective maintenance determined by trend analysis has already been planned and scheduled for many systems so that the SSBN operating cycle will not be disrupted.

In February 1974 the CNO approved the SSBN EOC program under the SMMS concept for submarines equipped with Poseidon missiles. Current SMMS Program objectives include extending the operating cycle to 10 years between overhauls, assessing the material condition of vital ship systems, providing improved engineering support of SSBNs, and improving other logistics support to Forces Afloat by better Fleet liaison and more timely scheduling of maintenance prior to equipment failure. Full implementation of the SMMS Program for all SSBNs occurred during 1977.

2.2 Integrated Maintenance and Modernization Planning (IMMP)/Submarine Extended Operating Cycle (SEOC) Programs

Although not yet as comprehensive as the SSBN strategy, an engineered, integrated attack submarine (SSN) maintenance strategy is well into development and implementation. The SSN Integrated Maintenance and Modernization Planning (IMMP) Program was established in 1970 to define and improve upon periodic maintenance performed on significant non-nuclear equipments at the depot and intermediate maintenance levels. This program applies to the SSN 594, SSN 637, and SSN 688 submarines. PERA (SS) is responsible for managing the IMMP Program, developing and scheduling the requirements for each ship, preparing availability work packages, incorporating changes, and updating the program.

The Submarine Extended Operating Cycle (SEOC) Program was instituted in 1972 for all SUBSAFE SSN 594 Class and later SSN submarines. The operating cycle was extended from 43 to 70 months for these ships by the increased intermediate and depot level maintenance associated with the IMMP Program, by continued SUBSAFE monitoring, and by certification and installation of the long-life reactor core during new construction or refueling overhauls.

2.3 Trident Maintenance Management Program (TMMP)

An integral part of the TMMP is the Trident Performance Monitoring and Analysis Program (TPMAP), which is currently in development and is expected to be implemented with commissioning of the first Trident submarine. The primary objectives of TPMAP are (1) to increase the availability of ship systems during patrols; (2) to reduce operating costs by eliminating unnecessary maintenance; and (3) to identify degradation trends, develop maintenance actions, and facilitate other logistic support. The primary development guidelines of this program included using existing monitoring and analysis techniques; focusing primarily on the HM&E areas of systems; using data collected via conventional methods; using noise and vibration monitoring capability; minimizing Ship's Force involvement in monitoring; providing a method for verifying the quality of repair work performed; and, finally, providing a procedure for evaluating the program's effectiveness.

In some ways the TPMAP is similar to the SMMS program for SSBNs; e.g., they both emphasize performance monitoring. In addition, the Trident and SSBN Classes have similar operating profiles.

Prior to TPMAP implementation for the Trident submarine, formal Logistic Support Analyses (LSA) were prepared to translate maintenance concepts and maintenance plans into logistic element requirements. Through the LSA process, specific maintenance actions and the maintenance level at which they were to be performed were determined by critical examination and engineering analysis -- including Repair Level Determination, Failure Modes and Effects Analysis (FMEA), and review of experience.

3. SURFACE SHIP PROGRAMS

3.1 Destroyer Engineered Operating Cycle (DDEOC)

The DDEOC Development Program is a major maintenance initiative supporting CNO Objective No. 3 (Improve the Material Condition of the Fleet) under the Ship Support Improvement Project (PMS-306). It encompasses several classes of surface combatants (FF-1052, DDG-37, CG-16, CG-26, and DDG-2) totaling 97 ships. The feasibility of extending operating cycles for certain ship classes was established by studies completed in 1974, which resulted in direction to develop a detailed maintenance policy and implementation plan.

The primary program objective is to effect early improvement in and maintain a high level of material condition over an extended operating cycle for the specified ships at an acceptable cost. The preliminary program guidelines include the following:

- An operating cycle of approximately 54 months encompassing three deployments
- Phased introduction by class
- An initial comprehensive Baseline Overhaul (BOH) in place of scheduled ROHs for each ship prior to entry into the extended cycle
- An engineered, integrated, intra-cycle maintenance plan incorporating dedicated depot-level availabilities

The ships in this program previously had a nominal recurring operating interval of 37 months with a 7-month overhaul. The new cycle will shift the ships to a 54 ± 6 months interval. A Baseline Overhaul will provide a full range and depth of repairs before these ships are placed on this extended cycle, both to assure an initial adequate material condition and to establish a known condition for monitoring. Depot-level, restricted availabilities are scheduled at 19-month intervals in the operating cycle. Reducing the frequency of overhauls would permit an additional deployment period for the ship and reduction in the crew retraining time associated with the overhauls as currently scheduled.

The maintenance requirements for these ships are being analyzed and engineered to determine how current maintenance support concepts must be changed to achieve the Engineered Operating Cycle. The Baseline Overhauls for the FF-1052 Class ships have been planned and execution commenced in FY 1977; the other classes will follow. In order to maintain material condition at an acceptable level during the operating period, a maintenance management system is being developed. This system will provide detailed planning for the depot and intermediate availabilities during the operating interval. To provide a "feedback" mechanism for modification of the maintenance system and continuous assessment of material condition, Material Condition Assessment teams will be placed at the Fleet level.

3.2 Lo-Mix Engineered Operating Cycle Program

The FFG-7 and PHM-1 Classes were designed to be supported by non-traditional methods. Each of these classes has a limited on-board crew. The FFG-7 Class is designed for progressive overhauls that eliminate periodic, long overhaul periods. Both the FFG and PHM have been designed to permit component removal, facilitating repair by change-out. These design concepts require the development of maintenance and logistic support systems different from those in existing ships.

For the FFG-7 Class, major modification is accomplished at the end of 10 years; a depot availability of 28 days is scheduled every 2 years; and, within these 2-year periods, planned intermediate-level availabilities are scheduled every 6 months. The traditional 7-month to 9-month regular overhaul every 3 years is no longer scheduled; in its place is a 1-month depot availability every 2 years. As a result, technical and logistic support communities must make adjustments to accommodate these new maintenance concepts.

The Lo-Mix approach is to engineer the maintenance and support requirements, including intermediate- and depot-level availabilities. This approach also includes engineering analysis of installed equipment and systems to determine their failure modes and effects and, through a logic process, determine what support they require. The analysis determines the preventive maintenance plan, estimates the corrective maintenance requirements, and establishes the level of repair -- organizational, intermediate, or depot. From these analyses, the supply requirements for rotatable pools are being determined. These pools will be necessary to achieve the quick turnaround times in the short intermediate- and depot-level availabilities and to minimize the corrective maintenance burden at the organizational level for operational failures. Dedicated rework capability for shipboard repairables is being developed. In addition, a tailored set of technical documents is being developed and will be provided to these ships. Finally, a Logistic Data System, adopted from the Trident Program, is being established to store, retrieve, and process the data from the engineering analysis.

APPENDIX B

COMPARISON OF CURRENT AND ALTERNATIVE SHIPBOARD MAINTENANCE STRATEGIES

1. INTRODUCTION

The purpose of this appendix is to provide insight into considerations important to the formulation of alternative ship maintenance strategies. A comparative analysis of the current maintenance strategy and a range of alternatives conducted during the Initiation Phase of a new EOC program is the principal task of the Initiation Study. This study specifically addresses effectiveness, resources required, and benefit to be gained by altering a ship class maintenance strategy. The results of the Initiation Study will contribute heavily to the decision to approve or disapprove the development of a new EOC program.

The study is conducted by comparing, by ship class, the current material condition and maintenance strategy with alternative proposed EOC maintenance strategies. Its objective is to identify the best and most feasible maintenance strategy, which then becomes the preliminary strategy to be expanded during the Development Phase of the EOC program.

2. DEFINITIONS

Several maintenance-related definitions are important to keep in mind (others are contained in Appendix J):

- Maintenance Strategy - Statement of philosophy of and approach to the conduct of maintenance. The maintenance strategy includes the general rules that initiate the performance of maintenance, criteria to shape the allocation of maintenance resources, and the assumptions to be used during maintenance planning.

- Maintenance Levels - The three levels of ship maintenance are:

  - Organizational (Shipboard) Maintenance - Maintenance that is the responsibility of and performed by the Ship's Force on assigned equipment.

- Intermediate Maintenance - Maintenance normally performed by Navy personnel on tenders, repair ships, aircraft carriers, Fleet support bases, and FMAGs. It normally consists of calibration, repair, or replacement of damaged or unserviceable parts, components, or assemblies; the emergency manufacture of unavailable parts; and provision of technical assistance to using organizations. Additional Shore IMAs (SIMAs) are programmed for operational use in the early 1980s to augment existing facilities.

- Depot (Shipyard) Maintenance - Maintenance performed by industrial activities on material requiring major overhaul or a complete rebuild of parts, assemblies, subassemblies, and end items, including parts manufacture, modification, testing, and reclamation as required. This is normally accomplished at commercial facilities or Naval shipyards, including ship repair facilities, during restricted availabilities, technical availabilities, and Regular Overhauls.

- Corrective Maintenance (CM) - The sum of those actions required to restore equipment to an operational condition within predetermined limits.

- Preventive Maintenance (PM) - Maintenance that improves the performance of an equipment and prevents incipient failures. The OPNAV definition is "the sum of those actions performed on operational equipment that contribute to uninterrupted operation of equipment within design characteristics".

- Methods of Parts Replacement - The three methods of replacing parts are:

  - Piece Part Replacement - Replacement of the individual failed piece or part as identified on the manufacturer's drawing. It is the most common method of repair.

  - Modular/Subassembly Replacement - Replacement of the entire module or subassembly, if the failed part itself is not easily removable but is part of a module or subassembly that is easily replaceable. The removed module or subassembly can be discarded or returned to a repair facility, reconditioned, and returned to stock. This method of repair is most commonly used for electronic equipment such as circuit boards.

  - Rotatable Pool Replacement - This method of repair is limited to major assemblies that have been identified for maintenance management as part of a specific Rotatable Pool Program. This method is generally employed only when major corrective or restorative maintenance is required. It consists of

replacing the entire assembly with a new or refurbished one, sending the replaced assembly to a designated repair facility for maintenance, then returning the repaired assembly to stock. The principal advantage is the reduced downtime of shipboard equipment. The principal disadvantage is the additional cost of establishing the initial supply of ready spare equipment.

- Maintenance Timing - The timing of maintenance is in accordance with one of three methods:

  - Periodic - This method requires that some maintenance be performed at specific intervals, regardless of equipment material condition. The extent of the maintenance may, however, depend on the material condition, e.g., "clean and inspect strainer every 6 months; repair or replace as necessary". This method of maintenance timing is generally invoked when the equipment wear-out rate is predictable and is a function of time (usually operating time of equipment utilized at a relatively constant rate).

  - On-Condition or Condition Dependent - This method requires that the equipment material condition be monitored regularly through the operating cycle and that maintenance be performed only when the material condition deteriorates beyond certain specified limits, e.g., "Replace journal bearing when clearance exceeds 0.008 in". This method of maintenance timing is generally specified when deteriorated material condition is readily discernable, unacceptable limits are definable, and wear-out rate may or may not be constant.

  - Run-to-Failure - Some equipments exhibit no characteristics that can be interpreted as indicating a need for maintenance or of imminent failure. Furthermore, their periods of satisfactory operation have no apparent correlation with time. They therefore do not lend themselves to either periodic or on-condition maintenance and the most practical policy is to run them to failure.

3. NAVY MAINTENANCE POLICY

As a general policy, in order to maximize operational readiness of the Fleet units and to minimize costs, ship maintenance is performed at the lowest level of maintenance activity consistent with capabilities and resources. Repairs to ships and their equipment not requiring the facilities of a shore-based activity are performed by Forces Afloat. Navy policy requires ships to be as self-sufficient as possible.

Several recent changes have precipitated the need to reevaluate the guidelines and policies governing maintenance strategies. New ship designs and missions have been introduced to respond to new operational threats and the number of ships to meet operational commitments has been reduced. Some ship classes have had a reduction in crew size (ship manning) and an imposition of limitations and constraints on maintenance resources.

The reevaluations have indicated that, in general, the Navy maintenance policies and guidelines are still appropriate. However, the interpretation of those policies and guidelines must be reviewed to broaden the application of current strategies and to develop new and innovative maintenance strategies as necessary.

4. CURRENT MAINTENANCE STRATEGIES

Recently a study was undertaken to document a definitive current maintenance strategy for surface ships of the Navy. The study disclosed that except for ships now in EOC programs there is no quantitative documentation of current maintenance strategies. Qualitatively, however, it is possible to describe the elements of maintenance strategy applicable to general categories of ships. A matrix showing such categories appears as Table B-1.

Table B-1 depicts, for SURFLANT and SURFPAC ships, some current maintenance characteristics. In the broadest terms, it compares levels of repair, methods of repair, and timing of repair with ship operating cycles. The predominance of what is considered traditional strategy is evident. For the newer ship classes (FFG-7 and PHM) employing new operational and design concepts (Lo-Mix concepts; unmanned engine rooms; short, high-speed sorties, etc.), the traditional maintenance strategy has required considerable modification. For those ships, Table B-1 indicates a shift in emphasis from piece-part replacement to modular and subassembly replacement with a greater reliance on rotatable pools. For the PHM, a shift of level of repair from organizational to intermediate level is also apparent. Table B-1 shows differences between fleets in operating cycle, characteristics of cycle length, and number of deployments per cycle.

Other factors contributed to the difficulty in determining what constitutes current maintenance strategy. At the time most of the active Fleet ship classes were being built, the acquisition managers were not required to document maintenance strategy as is now required by Integrated Logistic Support and similar documents. For some classes of ships there are substantial differences among the maintenance strategies that were current when the ships were being built, present OPNAV or Fleet policies, and the maintenance being practiced on the ships today. Additionally, while most maintenance strategies must have a practical concern with peacetime operations, all must consider wartime requirements for sustained at-sea operations under less than optimum maintenance circumstances.

Table B-1. CURRENT MAINTENANCE CHARACTERISTICS BY SHIP CATEGORY — Date: Oct. 1977

Ship Category	Level of Repair			Method of Repair			Timing of Repair			Operating Cycle							
										Number of Deployments		Number of IMA Availabilities*		Number of Depot Availabilities*		Cycle Length (Mos)	
	Organization	Intermediate	Depot	Piece Part	Module/ Subassy	Rotatable Pool	Periodic	Condition-Dependent	Run-to-Failure	SURFLANT	SURFPAC	SURFLANT	SURFPAC	SURFLANT	SURFPAC	SURFLANT	SURFPAC
Carriers	P	S	S	P	S	N	P	N	N	4	-	3	-	1**	1**	65	-
Cruisers											3						50
Destroyers										3	2	7	8			53	45
Frigates																	
FF																	43
FFG				S	P	S											
Amphibious				P	S	N				2	3	6	9†			45	
Replenishment					N					2††	3	3#	10##			54	
Patrol Hydrofoils	S	P		S	P	S				40 Sorties		77		1		18	

P - Primary
S - Secondary
N - Negligible

NOTES: *Number of availabilities does not include concurrent IMA availability during ROH.

**Number of availabilities does not include 1 to 3 concurrent depot availabilities during IMA RAVs.

†Number of availabilities is 6 for LSTs and 7 for LPHs.

††Number of deployments is 4 for AFSs.

#Number of availabilities is 4 for AFSs.

##Number of availabilities is 7 for ARSs and ATSs.

5. MAINTENANCE STRATEGY CONSIDERATIONS

A method is needed for comparing current and alternative maintenance strategies for classes of ships that are candidates for EOC programs. Toward that end, Table B-2 was constructed, displaying a generalized list of ship maintenance strategy considerations. It relates factors affecting maintenance performance to elements of maintenance strategy that can be altered and suggests ways to measure the benefits of altered strategies. Once alterable maintenance strategy elements are agreed upon, factors of effectiveness and cost can be traded off.

6. MAINTENANCE STRATEGY ANALYSES

Table B-3 is a typical worksheet to be used in a maintenance strategy analysis. It lists alterable maintenance strategy elements from Table B-2 and provides space in which current strategies can be compared with alternative ones. Each element is identified and assigned an indicator of its present status. Cost factors, usually measureable for current strategies, are then developed for each element. For alternative strategies, changes in status and estimates of changes in costs are filled in. Estimates can be total costs or incremental costs figured from current costs. The information is then summarized for trade-off studies.

Table B-2. SHIP MAINTENANCE STRATEGY CONSIDERATIONS

Factors Affecting Maintenance Performance	Related Maintenance Strategy Elements That Could Be Altered	Examples of Types of Indicators of Ship Operational Availability, Material Condition, or Effectiveness
Parameters That Define the Ship Situation		
• Inherent Characteristics of Installed Equipment	• Ship and Ordnance Alterations or modernizations as planned in FMP	• Number of priority items approved
•• Reliability •• Maintainability •• Availability	• Replacement of high burden equipments with new design instead of repairing them	• Ratio: $\frac{\text{Operating Time}}{\text{Operating Time and Downtime}}$
• Operational Profile of Ship	• Ratio of underway days to total cycle days	• Ratio: $\frac{\text{Underway Days}}{\text{Total Cycle Days}}$
•• Operational tempo •• Operational cycle length •• Use (war/peace, tropics/arctic, long/short cruises)	• Months between depot level repairs or deployments per cycle	• Number of months, number of deployments
Resources and Techniques Available to Solve Maintenance Problems (Consider at each level of maintenance: organizational, intermediate, and depot)		
• Resources Available for Maintenance Support		
•• Time in port devoted to maintenance	• Ratio of maintenance days in port to total cycle days	• Ratio: $\frac{\text{Maintenance Days in Port}}{\text{Total Cycle Days}}$
•• Funds for maintenance activities	• Costs by appropriations	• Annualized dollar costs
•• Personnel	• Quality, quantity, training, turnover	• Ratios and rates used by BUPERS
•• Facility capabilities	• Test equipment, tools, machines, space	• Numbers related to work accomplished
•• Supply support	• Repair parts and material availability	• Time required to supply part on ship
• Maintenance Support Techniques		
•• Periodic •• On-condition (Preventive) •• Run-to-failure (Corrective)	• Preventive Maintenance System (PMS) • Material Condition Assessment (MCA)	• Man-hours required per ship • Failures prevented
•• Parts replacement methods	• Piece part • Module/Subassembly • Rotatable pool	• Numbers required, availability achieved
•• Offship maintenance management assistance	• EOC programs, TYCOM assistance, etc.	• Benefits related to resources required
•• Offship engineering assistance	• PERAs, NAVSEA Centers, etc.	• Benefits related to resources required

Table B-3. SHIP CLASS MAINTENANCE STRATEGY ANALYSIS WORKSHEET

Maintenance Strategy Elements Which Could be Altered	Current Strategy		Alternative Strategy	
	Indicator of Status	Related Costs	Change in Status	Change in Costs
Inherent Characteristics of Installed Equipments				
• Ship and Ordnance Alterations or Modernizations in FMP				
• Replace with new design				
Operational Profile of the Ship				
• Operational Tempo - Ratio: $\frac{\text{Underway Days}}{\text{Total Cycle Days}}$				
• Cycle Length - Months Between Depot Repairs or Deployments per Cycle				
Resources Available (Consider at each level of maintenance: organizational, intermediate, and depot)				
• Time in port devoted to maintenance - Ratio: $\frac{\text{Maintenance Days}}{\text{Total Cycle Days}}$				
• Funds - Annualized basis, by appropriations				
• Personnel - Quality, Quantity, Training, and Turnover				
• Facility Capability - Test equipment, tools, machines, space				
• Supply Support - Availability of repair parts and material				
Maintenance Support Techniques				
• Preventive Maintenance System (PMS)				
• Material Condition Assessment (MCA)				
• Replacement by piece part, module and subassembly, or rotatable pool				
• Offship maintenance management assistance				
• Offship engineering assistance				

APPENDIX C

EOC PROGRAM DATA

This appendix describes typical sources of data required for an EOC program. This list is not intended to be all-inclusive, but rather to show the types of data generally available. Table C-1, following the descriptions, classifies the types of data so that a reader can identify sources of data of any of the four categories: configuration, maintenance strategy, material condition, and resource requirements.

Alteration Records - These are individual documents written for approved alterations that provide a detailed description of the work required and logistical information. Copies of the alteration records are available from NAVSEA (director of the appropriate ship's logistic directorate) or cognizant PERA.

APL - The Allowance Parts List is a document prepared for individual equipments and components listing their associated repair parts and corresponding allowance and maintenance information. Microfiche copies can be obtained from the Navy Ship's Parts Control Center (SPCC).

CASREP - The Consolidated CASREP Reporting System is maintained by FMSO and makes available numerous summary reports of CASREPs submitted by the Fleet. Typical information available includes the number of CASREPs on a system level, the breakdown of CASREPs by severity codes, and the system downtime that resulted from the casualty. Historical reports available cover a maximum of three years from the request date and can normally be obtained within one to three weeks. Most reports are classified CONFIDENTIAL.

COSAL - The COSAL contains a consolidation of the various equipment APLs and AELs and provides a list of Onboard Repair Parts (OBRPs) required for the ship to achieve maximum self-supporting capability during extended operations. COSALs are scheduled and produced by the Navy Ships Parts Control Center (SPCC Code 573).

Combat System Readiness Review - This is a document that promulgates the results of a series of tests of ship combat systems conducted 90 to 120 days before a major deployment to ensure their operability. These documents can be obtained from NAVSEA 06 or Naval Sea Centers Atlantic and Pacific.

Departure Reports - Overhaul departure reports can be obtained through the cognizant Ship Logistic Manager at the Naval Sea Systems Command. They contain detailed information on jobs completed during the overhaul and include man-day and material expenditures. Lead time for obtaining these documents is two to four weeks.

Detailed Shipbuilding Specifications - These specifications provide the minimum ship class design and operational requirements including RMA factors and the intended maintenance strategy. They are available from SHAPMs and from the assigned Planning Yard.

Employment Schedules/Data - Ship employment data are available from the Chief of Naval Operations (NOP-643). These data are classified FOR OFFICIAL USE ONLY (with the exception of the most current quarter, which is classified CONFIDENTIAL) and can be obtained on computer magnetic tape or in hard copy. These data contain the number of days of each calendar quarter spent in various employment situations (e.g., in port, deployed, upkeep) for each ship of interest. Lead time to obtain these data is two to four weeks.

A second source of employment data is the Steaming, Operating, and Fuel Listing report available from MSOD. This report contains information on the steaming hours (under way, not under way, and cold iron) and fuel consumption by month for a selected ship or ship type. See FMSO Instruction 4790.4 series for complete details.

FMP - The Fleet Modernization Program Ordnance Improvement Plan (OIP) contains detailed information on FMP Ordnance Alterations (OrdAlts). The OIP can be obtained from the Naval Weapons Station, Concord, California, with a lead time of three to six weeks. More detailed information can be gleaned from the OrdAlt documents obtainable through the Weapons System Engineering Directorate (NAVSEA 06). Also see SAMIS.

FORSTAT Reports - These reports describe the operational capabilities and status of individual ships. They can be obtained from OPNAV within three to six months. The information can be used to assess ship availability.

Gun Weapon System Replacement Program - This program provides guidance and the schedule of the material inspections of the major gun weapon systems in the Fleet. The results of the inspections provide material condition information, which can be obtained from NAVSEA 0432.

IMMS - The reports available through the Intermediate Maintenance Activity Maintenance Management System (IMMS) provide an additional source of intermediate echelon maintenance history. Reports covering daily performance, specific ship availabilities, repair work center and department burden and productivity are available on a local basis. OPNAV Instruction 4790.4 series Volume 2 discusses these in detail.

INSURV - Board of Inspection and Survey (INSURV) reports detail material discrepancies identified during surveys of an individual ship and must normally be obtained through the EOC program sponsor. In addition to individual ship INSURV reports, reports of common INSURV discrepancies and ship class INSURV reports may be available. These reports are often classified CONFIDENTIAL.

LSA - For specific equipments Logistic Support Analyses identify and describe support and test equipment; facilities requirements; personnel required by skills, type and number; spares and repair parts; and maintenance and operational support needs. LSAs are available from SHAPMs and from assigned Planning Yards.

MDS - The Navy Maintenance Data System contains organizational level maintenance data, such as labor, part, and narrative records. The information available from MDS data is extensive. Data fields and reporting requirements are detailed in the Ship's Maintenance and Material Manual, OPNAV Instruction 4790.4 series. MDS data should be acquired from the Fleet Maintenance Support Office (FMSO), Maintenance Support Office Department (MSOD), Mechanicsburg, Pennsylvania. Ideally, the time covered by these data should be at least as long as the projected Engineered Operating Cycle.

NOTE: While numerous data summary and retrieval hard copy reports are available from MSOD (see FMSO Instruction 4790.2), those reports will not normally satisfy the requirements for accuracy, timeliness, or flexibility for data analysis.

MEA - For specific equipments, Maintenance Engineering Analyses identify and describe reliability data, maintainability and maintenance concepts, maintenance requirements, personnel requirements, support equipment requirements, and maintenance support and training facility requirements. MEAs are available from SHAPMs and from assigned Planning Yards.

MIAPL - The Master Index of APLs contains nine APL indexes and cross references such as the Standard Equipment/Component List and Technical-Manual-to-APL cross reference. Microfiche copies can be obtained from SPCC.

Military Specifications - These documents contain specific construction and performance requirements for equipment and can normally be obtained in two to four weeks from the Naval Publications and Forms Center, Philadelphia.

Military Standards - These documents contain specific construction and performance requirements for equipment and can normally be obtained in two to four weeks from the Naval Publications and Forms Center, Philadelphia.

NMDL - The Navy Management Data List is an index of piece parts and components by National Item Identification Number (NIIN) indicating unit cost, item nomenclature, and other ILS data. Microfiche copies can be obtained from SPCC.

PMS - Planned Maintenance System Data consist of Current Maintenance Index Pages (MIPs) and Maintenance Requirement Cards (MRCs) and specify maintenance requirements, periodicity, and personnel requirements for specific equipments. PMS data is maintained in master files by NAVSEC (Code 6106), Crystal City. This file can be used for occasional reference and copying of selected MIPs and MRCs.

SAMIS - The Ship Alteration Management Information System contains data on ship or class modernization and can be assessed by the EOC Program Manager or other NAVSEA codes to retrieve various reports related to modernization. Of particular use are the Amalgamated MIP/TIP report, which lists currently identified military and technical improvement ship alterations and ordnance alterations for a ship class, and the Mini-Fleet Modernization Program (FMP), which lists the identified ship alterations and ordnance alterations planned under the FMP for a particular ship over a specified fiscal year overhaul. The overhaul schedule for a particular ship or ship class is available in OPNAVNOTE 4710 (Fleet Overhaul Schedule). Since SAMIS is a computerized interactive system, lead time for reports is negligible.

SARP - Ship Alteration and Repair Packages are the chief sources of depot echelon historical maintenance data. SARPs can be obtained on loan from the cognizant PERA within two to four weeks. SARP documents contain a

detailed breakdown of the repairs, alterations, and the associated resource requirements scheduled for a regular overhaul by a depot facility.

SECAS - The Ship Equipment Configuration Accounting System (SECAS) validates shipboard configurations and provides reports based on these validation data to Navy activities. A catalog detailing available SECAS products is maintained by the Naval Sea Systems Command (NAVSEA 04K4) and should be consulted to identify desired SECAS reports.

Ship Information Books - These documents describe the ship design characteristics and major shipboard arrangements of the equipment aboard the ship. Ship Information Books (SIBs) are available for reference at the NAVSEA, Crystal City library. Additional copies of SIBs can normally be obtained through the cognizant NAVSEA ship acquisition or logistic manager of PERA. It usually takes three to six months to obtain them.

Ship Qualification Trials - These documents contain performance and material condition assessment data on the results of ship trials. Documents can be obtained through the Surface Warfare Officers School Command, Newport, R.I.

SNSL - The Standard Navy Stock Listing is a document containing NIIN-to-APL cross references in NIIN sequence for NIINs and APLs under the cognizance of the specific type commander. Microfiche copies can be obtained from SPCC.

System and Technical Manuals - Detailed technical data on the operation and maintenance of ship systems and equipments are contained in these manuals. They can be borrowed from the NAVSEC, Crystal City Technical library, with minimal lead time. Extra copies of these manuals can be requested from the Naval Publications and Forms Center, Philadelphia, with a lead time of three to six months.

TLR - The Top Level Requirement is a document promulgated and approved by the Chief of Naval Operations. It specifies the operational requirements of a ship to be built and stipulates the maximum cost and all other program constraints affecting the design and use of the ship. As a minimum, the Top Level Requirement states the ship's mission, operational requirements, major configuration constraints, the plan for use, the maintenance concepts, the supply support concepts, manning limitations, minimum operational standards, and maximum allowable cost. TLRs are generally available from SHAPMs.

TLS - The Top Level Specification is a document promulgated by the Naval Ship Systems Command that translates the Top Level Requirements into a detailed ship description, providing a bridge between the Top Level Requirements and the ship procurement specifications. The Top Level Specification is developed in parallel with the Top Level Requirements and is completed shortly after the Top Level Requirements and before a request for OSD program approval.

Total Ship Test Program - The data provided are the results of a series of integrated tests prescribed for shipboard testing of systems from component through system level. The tests are written to test ships that report less than satisfactory performance. Source of information about these tests is NAVSEA 046.

Technical Repair Standard - This standard specifies the minimum requirements for the acceptable repair and refurbishment of a system, equipment, or unit. These documents can be obtained from the cognizant PERAs within two to four weeks.

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ENGINEERED OPERATING CYCLE PROGRAM DEVELOPMENT MANUAL,(U)
AUG 78 R A MONDOR N00140-77-D-0417
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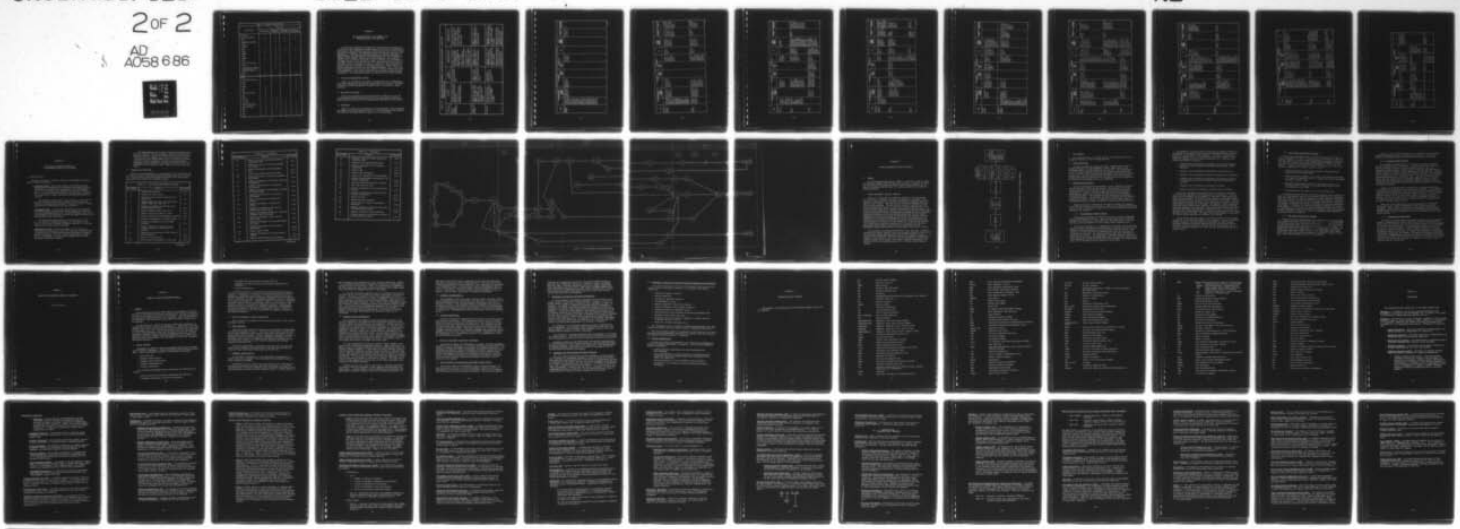

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Table C-1. SOURCES OF DATA BY TYPE

Data Sources	Data Type			
	Configuration	Material Condition	Maintenance Strategy	Resource Requirements
Historical				
Departure Reports	X	X	X	X
MDS	X	X	X	X
Employment Schedule		X	X	
SECAS	X			
FORSTAT		X		
SARP	X	X	X	X
IMMS	X	X	X	X
CASREP	X	X		
CSRR		X		
INSURV	X	X		X
TSTP	X	X		
Ship Qualifications		X		
GWSRP	X	X	X	
Fleet Missile Analysis and Evaluation Group Technical Reports		X		
SAMIS	X			X
FMP	X			X
Design				
Ship Specifications	X	X	X	X
SNSL				X
NMDL				X
MIAPL	X			X
APL	X			X
AEL	X			X
Alteration Record	X			
SIB	X			
EIMB	X	X		
MIL STD	X	X	X	
MIL Spec	X	X	X	
System Tech Manual	X	X	X	X
PMS (MIPs/MRCs)	X	X	X	X
MEA	X	X	X	X
LSA	X	X	X	X
TLR	X		X	X
TLS	X		X	X

APPENDIX D

EOC PROGRAM FUNCTIONS, ASSIGNMENTS, AND RESPONSIBILITIES (FAR) MATRICES

Previous EOC programs have effectively used matrices to display projected and actual management and administration of the various elements of the program. These matrices provide a succinct description of EOC Program Functions, Assignments and Responsibilities (FAR) and are referred to as FAR Matrices. The SSBN Ship System Maintenance Monitoring and Support (SMMS) Program used FAR matrices very successfully and the DD Engineered Operating Cycle (DDEOC) program used similar matrices. This appendix contains, for illustrative purposes, copies of FAR matrices developed for the DDEOC program. Such matrices are first developed during the Development Phase of an EOC program and used as a vehicle to gain concurrence on program Functions, Assignments and Responsibilities. FAR matrices are usually published as part of the EOC Program Management Plan. During program implementation the matrices are updated to reflect engineering needs or realignments. Three types of matrices are described in the following subsections. The illustrative tables are samples from the DDEOC program.

1. POLICY AND HEADQUARTERS SUPPORT

Table D-1 illustrates the specific responsibilities of headquarters-level Navy commands and the program support they will provide. The matrix includes the program management, program funding, and personnel support functions.

2. AVAILABILITY PLANNING

Table D-2 illustrates how EOC organizational elements fit into the current BOH-ROH-SRA-RAV-IMA Planning cycle and gives specific planning responsibilities for the various organizations supporting the EOC program.

3. OPERATIONS

Table D-3 illustrates development and implementation of EOC assessment procedures and EOC Site Team ship visits. It also addresses data handling and technical and administrative support for the EOC program.

Table D-1. SAMPLE FUNCTIONS, ASSIGNMENTS, AND RESPONSIBILITIES MATRIX -- POLICY AND HEADQUARTERS SUPPORT

Function	CNO/CNM	Fleet Commanders	COMNAVSEASYSCOM	COMNAVSUPSYSCOM
DDEOC Program Management	Provide overall policy direction and program sponsorship Promulgate Baseline Overhaul requirements	Execute program as directed by CNO	Develop a detailed maintenance policy and implementation plan to support the DDEOC Program Identify Baseline Overhaul requirements Coordinate ILS requirements to support maintenance policy	Develop supply procedures which will support DDEOC Program intracycle availabilities, at both IMA and depot levels
Budget and Funding	Coordinate and submit budget in support of DDEOC Program. Provide resources for execution of program including Baseline Overhaul	Submit to CNO budget recommendations with full justifications	Submit to CNO, via CHNAVMAT, budget recommendations with full justifications	Submit to CNO, via CHNAVMAT, budget recommendations with full justifications
Personnel	Review and approve military and civilian billet requirements to support DDEOC Program	Requisition personnel to fill approved billets	Identify to CNO, via CHNAVMAT, military and civilian billets needed to support the DDEOC Program Requisition military personnel and recruit civilians to fill approved billets	Identify to CNO, via CHNAVMAT, military and civilian billets needed to support the DDEOC Program Requisition military personnel and recruit civilians to fill approved billets

Table D-2. SAMPLE FUNCTIONS, ASSIGNMENTS, AND RESPONSIBILITIES MATRIX -- AVAILABILITY PLANNING

Function	NAVSEASYSCOM SEA-934	DDEOC Program Office SEA-934X	PERA (CRUDES)	DDEOC Technical Group	Type Commander: DDEOC Site Team	Type Commander	Ship	Industrial Activity (NAVSHIPYD/ SUPSHIP)	NAVSEASYSCOM SEA-04	NAVSUPSYSCOM (Including SPCC)
Modernization Planning (General)	Develop time-phased Class Improvement Plans (CIPs) for DDEOC ship classes, as directed by CNO. CIPs will include Military and Technical Improvements with associated feasibility studies, including changes in service demands, weight and moment, and configuration. CIPs are to be approved and promulgated by CNO and implemented by the normal FMP process. Coordinate with NAVELEXSYSCOM for matters under the cognizance of that command.	Recommend reliability and maintainability Title "K" ShipAlts for inclusion in CIPs.	Provide technical support and alteration applicability status, as required.			Provide alteration completion status and recommend priorities.			Maintain alteration material requirement records in SAMIS.	

(continued)

Table D-2. (continued)

Function	NAVSEASYSCOM SEA-934	DDEOC Program Office SEA-934X	PERA (CRUDES)	DDEOC Technical Group	Type Commander DDEOC Site Team		Ship	Industrial Activity (NAVSHIPYD/ SUPSHIP)	NAVSUPSYSCOM (Including SPCC)	NAVSEASYSCOM SEA-04
BOH Planning										
Alteration package development	Authorize and initiate funding for accomplishment of Title "K" ShipAlts and OrdAlts with associated Selected Records Data and Plans. Fund PERA (CRUDES) and shipyard for advance planning, including drawing development and material procurement. Recommend priorities for the Fleet modernization process.	Identify and recommend for accomplishment reliability and maintainability ShipAlts for support of DDEOC.	Conduct alteration ship-check, and report completion status and status of design software.			Authorize and fund Title "D" and "F" ShipAlts. Recommend priorities for the Fleet modernization process for Title "K" ShipAlts.	Review authorized alterations for completion status.	Initiate advance procurement of material required for authorized alterations. Prepare design software, as directed. Prepare COSAL inputs.	Coordinate and maintain the status of Fleet Modernization Program alterations and material requirements in accordance with NAVSEAINST 4720.3 and 4720.10.	Provide commodity management and procurement services in support of the Fleet Modernization Program for those items assigned to NAVSUP for inventory management.
Repair package development	Fund PERA (CRUDES) for preparation of class repair planning documentation.	Develop and promulgate DDEOC "Repair Requirements for BOH" from various analyses, etc. Promulgate "Repair Profile for Baseline Overhaul".	Develop "Repair Profile for Baseline Overhaul" including Type Commander routines and industrial support services. Generate POT&I plan and task execution. Assist ship in CSMP update.			Provide automated CSMP readout. Authorize advance procurement of repair material. Fund PERA(CRUDES) and shipyard efforts in POT&I and SARP development for individual ships.	Review and update CSMP. Conduct POT&I (ship's portion).	Conduct POT&I (shipyard portion). Generate POT&I report with cost estimates. Initiate advanced material procurement, as authorized.	Provide inventory management services as required.	Provide commodity management and procurement services for those items assigned to NAVSUP for inventory management.

(continued)

Table D-2. (continued)

Function	NAVSEASYSCOM SEA-934	DDEOC Program Office SEA-934X	PERA (CRUDES)	DDEOC Technical Group	Type Commander DDEOC Site Team		Ship	Industrial Activity (NAVSHIPYD/ SUPSHIP)	NAVSEASYSCOM SEA-04	NAVSUPSYSCOM (Including SPCC)
BOH Planning										
SARP development	Fund initial class "Baseline SARP" development. Provide contract administration services for certain private sector overhauls.		Generate class "Baseline SARP". Generate proposed SARP for use at W.D.C. Attend W.D.C.			Conduct W.D.C. Screen proposed SARP and authorize work (authorized SARP).	Attend W.D.C.	If directed, prepare proposed SARP. Attend W.D.C.		
Special assistance items	Fund and coordinate FILS support, Technical Repair Standard development, and SECAS validation. Authorize and initiate funding for advance COSAL effort.		Train and assist Ship's Force in operation of SFOMS. Provide FILS program support, as directed. Develop Technical Repair Standards. Develop post-repair Test and Certification plans. Generate bid specifications for private overhauls.			Fund SFOMS implementation. Provide COSAL validation instructions. Schedule SOAP. Provide IEM (ex-PMDO) package.	Conduct COSAL validation. Assist SECAS validation. Conduct SOAP and repair parts inventory.	Perform all work items authorized for industrial activity accomplishment. Provide SFOMS support, as directed. Perform certifications, as directed. Schedule load COSAL quality review. Provide allowance inputs. Provide Allowance Appendix Pages (AAP) and submit Summary List Component Changes (SLCC) to SPCC.	Coordinate advance COSAL effort.	Provide validation aids and SOAP aids. Publish baseline COSAL and post-overhaul COSAL Index, conduct COSAL quality review and COSAL Index quality review. Publish preliminary Equipment Certification Index.
Post-BOH assessment		Review overhaul reports of deficiencies and coordinate resolution, as applicable.	Review reports of overhaul deficiencies and deferred actions and enter them into intra-cycle maintenance management system.	Collect initial reports of ship's material condition to establish baseline for trend analyses.	Conduct initial assessment of ship's material condition on selected equipments and forward data to DDEOC Technical Group.	Provide for correction of overhaul deficiencies, as appropriate.	Report overhaul work deficiencies and incorporate them into CSMP. Assist DDEOC Site Team in data collection, as required. Sign for repair parts load.	Report to TYCOM, NAVSEA, and PERA (CRUDES) deferred repairs and incomple e alterations at time of BOH completion. Certify Baseline COSAL and conduct COSAL turnover conference.		

(continued)

Table D-2. (continued)

Function	NAVSEASYSCOM SEA-934	DDEOC Program Office SEA-934X	PERA (CRUDES)	DDEOC Technical Group	Type Commander DDEOC Site Team		Ship	Industrial Activity (NAVSHIPYD/ SUPSHIP)	NAVSEASYSCOM SEA-04	NAVSUPSYSCOM (Including SPCC)
SRA Planning										
Alteration package development	Authorize and initiate funding for necessary, urgent Title "K" ShipAlts or OrdAlts with associated software.	Identify and recommend reliability and maintainability ShipAlts for support of DDEOC.	Report completion status and status of design software.			Authorize and fund Title "D" and "F" ShipAlts.	Review authorized alterations for completion status.	Initiate advance procurement of material required for authorized alterations. Prepare design software, as directed.	Coordinate and maintain status of Fleet Modernization Program alteration requirements in accordance with NAVSEAINST 4720.3 and 4720.10.	Provide commodity management and procurement services in support of the Fleet Modernization Program for those items assigned to NAVSUP for inventory management.
Repair package development		Develop and promulgate "Class Maintenance Plan", identifying hard-time intracycle maintenance actions and repair actions contingent upon condition assessment trend analyses.	Develop and maintain an ADP intracycle maintenance management system (RMMS) that will generate a repair work list for the SRA. Assist ship in CSMP update. Generate SRA-proposed SARP. Assist Type Commander in screening process.	Recommend repair actions based on condition assessment trend analyses.	Recommend repair actions based on observations during assessment visits.	Provide automated CSMP readout. Authorize advance procurement of repair material. Screen proposed SRA SARP and authorize work. Fund PERA(CRUDES) and industrial activity efforts in repair package development.	Review and update CSMP. Assist DDEOC Site Team in data collection, as required.	If directed, prepare proposed SRA SARP with cost estimates. Initiate advance material procurement, as authorized.	Provide inventory management services as required.	Provide commodity coordination and procurement and stocking services for items in DDEOC Class Maintenance Plans.
Special assistance items						Assist TYCOM in implementation of supply aids. Provide COSAL update assistance.	Process SRA supply aids.		Coordinate NAVSUP and TYCOM assistance unit COSAL activities.	Provide SRA supply aids, as required.

(continued)

Table D-2. (continued)

Function	NAVSEASYSCOM SEA-934	DDEOC Program Office SEA-934X	PERA (CRUDES)	DDEOC Technical Group	Type Commander DDEOC Site Team		Ship	Industrial Activity (NAVSHIPYD/ SUPSHIP)	NAVSEASYSCOM SEA-04	NAVSUPSYSCOM (Including SPCC)
SRA Planning Post-SRA assessment		Review reports of deficiencies and coordinate resolution, as applicable.	Review reports of availability deficiencies and deferred actions, and enter into intracycle maintenance management system.	Collect reports of ship's material condition, for purpose of updating trend analyses.	Assess ship's material condition on selected equipments, as scheduled, and forward data to DDEOC Technical Group.	Provide for correction of availability deficiencies, as appropriate.	Report availability work deficiencies, and incorporate into CSMP. Assist DDEOC Site Team in data collection, as scheduled.	Complete all work items authorized for industrial activity accomplishment. Perform certifications as directed. Report to TYCOM, NAVSEA, and PERA(CRUDES), deferred repairs and incomplete alterations at time of SRA completion.		
ROH Planning Alteration package development	Authorize and initiate funding for accomplishment of Title "K" ShipAlts and OrdAlts with associated Selected Record Data and Plans. Fund PERA (CRUDES) and Shipyard for advance planning, including drawing development and material procurement. Provide inputs to the Fleet modernization prioritization process.	Identify and recommend for accomplishment, reliability and maintainability ShipAlts for support of DDEOC.	Conduct alteration ship-check, and report completion status and status of design software.			Authorize and fund Title "D" and "F" ShipAlts. Recommend priorities for the Fleet modernization process for Title "K" ShipAlts.	Review authorized alterations for completion status.	Initiate advanced procurement of material required for authorized alterations. Prepare design software, as directed. Prepare COSAL inputs.	Coordinate and maintain status of Fleet Modernization Program alteration requirements in accordance with NAVSEAINST 4720.3 and 4720.10.	Provide commodity management and procurement services in support of the Fleet Modernization Program for those items assigned to NAVSUP for inventory management.

(continued)

Table D-2. (continued)

Function	NAVSEASYSCOM SEA-934	DDEOC Program Office SEA-934X	PERA (CRUDES)	DDEOC Technical Group	Type Commander DDEOC Site Team		Ship	Industrial Activity (NAVSHIPYD/ SUPSHIP)	NAVSEASYSCOM SEA-04	NAVSUPSYSCOM (Including SPCC)
ROH Planning										
Repair package development	Fund PERA (CRUDES) for preparation of class repair planning documentation. Provide contract administration services for certain private sector overhauls.	Develop, maintain, and promulgate "Class Maintenance Plan", identifying hard-time requirements for overhauls after the BOH, and repair actions contingent upon condition-assessment trend analysis.	Maintain an ADP intracycle maintenance management system (RMMS) which will generate a repair work list for the ROH. Generate POT&I plan and task execution. Assist ship in CSMP update. Generate ROH-proposed SARP for use at W.D.C. Attend W.D.C.	Recommend repair actions based on condition-assessment trend analyses.	Recommend repair actions on the basis of observations during assessment visits.	Fund PERA (CRUDES) and shipyard efforts in POT&I and SARP development for individual ships. Provide automated CSMP readout. Authorize advance procurement of repair material. Conduct W.D.C. Screen proposed SARP and authorize work (authorized SARP).	Review and update CSMP. Conduct POT&I (ship's portion). Assist DDEOC Site Team in data collection, as required. Attend W.D.C.	Conduct POT&I (shipyard portion). Generate POT&I report with cost estimates. Initiate advanced material procurement, as authorized. If directed, prepare proposed SARP. Attend W.D.C.	Provide inventory management services as required.	Provide commodity management and procurement services for those items assigned to NAVSUP for inventory management.
Special assistance items	Fund and coordinate FILS support, Technical Repair Standard development, and SECAS validation. Authorize and initiate funding for advance COSAL effort.		Train and assist Ship's Force in operation of SFOMS. Provide FILS program support, as directed. Develop Technical Repair Standards. Develop post-repair Test and Certification plans. Generate bid specifications for private sector overhauls.			Fund SFOMS implementation. Provide COSAL validation instructions. Schedule SECAS validation. Schedule SOAP. Provide IEM (ex-PMDO) package.	Conduct COSAL validation. Assist SECAS validation. Conduct SOAP and repair parts inventory.	Perform all work items authorized for industrial activity accomplishment. Provide SFOMS support, as directed. Perform certifications, as directed. Schedule load COSAL quality review. Provide allowance inputs. Provide AAP package and submit SLCCs.	Coordinate advance COSAL effort.	Provide validation aids and SOAP aids. Publish baseline COSAL and post-overhaul COSAL index. Conduct COSAL quality review and COSAL index quality review. Publish PECI.
Post-ROH assessment		Review reports of deficiencies and coordinate resolution, as applicable.	Review reports of overhaul deficiencies and deferred actions, and enter them into intra-cycle maintenance management system.	Collect reports of ship's material condition, for purpose of updating trend analyses.	Conduct assessments of ship's material condition, as scheduled, and forward results to DDEOC Technical Group.	Provide for correction of overhaul deficiencies, as appropriate.	Report overhaul work deficiencies and incorporate into CSMP. Assist DDEOC Site Team in data collection, as scheduled. Sign for repair parts.	Report to TYCOM, NAVSEA, and PERA (CRUDES) deferred repairs and incomplete alterations at time of ROH completion. Certify baseline COSAL and conduct COSAL turnover conference.		

(continued)

Table D-2. (continued)

Function	NAVSEASYSCOM SEA-934	DDEOC Program Office SEA-934X	PERA (CRUDES)	DDEOC Technical Group	Type Commander DDEOC Site Team		Ship	Industrial Activity (NAVSHIPYD/ SUPSHIP)	NAVSEASYSCOM SEA-04	NAVSUPSYSCOM (including SPCC)
IMA Planning		Develop, maintain, and promulgate "Class Maintenance Plan", identifying hard-time intracycle maintenance requirements, and repair actions contingent upon condition-assessment trend analyses.	Maintain an ADP intracycle maintenance management system that will generate a repair work list for any intracycle availability (RMMS). Assist Type Commander in screening process and provide planning assistance as requested.	Recommend repair actions based on condition-assessment trend analyses.	Conduct assessments of ship's material condition on selected equipments, as scheduled, and forward data to DDEOC Technical Group. Recommend repair actions based on observations during assessment visits.	Fund PERA (CRUDES) efforts in repair package development. Schedule and assign IMA availabilities. Screen proposed IMA work package. Authorize and fund work. Record work item completion status and forward to PERA (CRUDES) for entry into ADP intracycle maintenance management system.	Review and update CSMP. Assist DDEOC Site Team in data collection, as required. Submit work requests for screening action.		Coordinate COSAL Improvement Program Actions.	Provide IMA supply aids, as necessary. Provide commodity management coordination and procurement and stocking services for items in DDEOC Class Maintenance Plans.
RAV Planning (Unscheduled)	Provide planning assistance, as required.	Recommend urgent opportune work items.	Maintain an ADP intracycle maintenance management system that will generate a repair work list for the availability. Provide RMMS outputs to Type Commander for entry into the automated CSMP. Assist Type Commander in availability planning, as required.	Recommend opportune work items on the basis of trend analysis.	Recommend opportune work items based on observations during assessment visits.	Fund PERA (CRUDES) and industrial activity efforts in repair development. Assign availability. Review CSMP and RMMS outputs for opportune work items. Screen proposed work package. Authorize and fund work. Record work item completion status and forward to PERA(CRUDES) for entry into RMMS.	Recommend opportune work items.	Provide planning assistance, as necessary.	Coordinate COSAL Improvement Program Actions.	Provide RAV supply aids, as necessary.

Table D-3. SAMPLE FUNCTIONS, ASSIGNMENTS, AND RESPONSIBILITIES MATRIX -- OPERATIONS LEVEL

Function	NAVSEASYSCOM SEA-934		PERA (CRUDES)		Type Commander		Ship
		DDEOC Program Office SEA-934X		DDEOC Technical Group	DDEOC Site Team		
Material Condition Assessment (MCA) Procedure Development		Chair MCA Review Board for approval of systems and equipments for for development. Initiate development of assessment procedures (tasking, contracting, etc.), as required. Coordinate review of procedures with technical codes and Type Commander, as appropriate. Promulgate approved procedures for implementation. Coordinate integration of procedures into 3-M system, as appropriate.	Provide engineering services for development and review of assessment procedures, as requested. Assist DDEOC Technical Group, as required.	Participate in MCA Review Board. Develop MCA procedures, as tasked. Conduct analysis of available maintenance information and make recommendations for new assessment procedures. Review procedures for technical and operational adequacy.	Participate in MCA Review Board. Assist in MCA procedure development. Recommend systems and equipments for assessment program. Review procedures and field test for procedural adequacy and operational feasibility.	Review procedures for feasibility of implementation and provide recommendations in areas of concern.	Provide operational assistance to DDEOC Site Team, as required, during field test of procedures.
MCA Procedure Implementation		Chair MCA Review Board for approval of developed MCA procedures. Coordinate updating of appropriate technical documentation (NAVSEA Technical Manual, drawings, MRCs, TRSs, etc.)	Revise technical documentation, as appropriate.	Review ship upkeep schedules and deviations from past schedules for DDEOC procedures that are to be accomplished in next upkeep. Establish priorities for assessment procedures. Recommend procedures for accomplishments.	Indoctrinate ship's crews on assessment procedures. Accomplish assessment procedures on ships, as scheduled. Maintain schedules and records of accomplishment of assessment procedures.	Provide DDEOC Technical Group and DDEOC Site Teams with ship upkeep schedules. Coordinate implementation of assessment procedures.	Schedule DDEOC assessment procedures into ship's 3-M System, as applicable. Conduct assessments, as required, at sea, where conditions cannot be simulated in port. Provide DDEOC Site Team with data from these assessments.
Changes to MCA Procedures		Coordinate procedure change recommendations. Promulgate approved changes.	Review recommended changes to assessment procedures for technical adequacy, as requested.	Continuously review available data for procedural updating or revision. Review and promptly act upon all recommended changes.	Submit any recommended changes to the Type Commander, the DDEOC Technical Group, and the DDEOC Office.	In coordination with the DDEOC Office, evaluate all significant operational and performance criteria changes.	Submit any recommended changes to the Type Commander and the Site Team.

(continued)

Table D-3. (continued)

Function	NAVSEASYSCOM SEA-934	DDEOC *Program Office* SEA-934X	PERA (CRUDES)	DDEOC *Technical* Group	Type Commander DDEOC *Site* Team		Ship
Forwarding of Monitoring Data		Facilitate technical liaison, as requested.	Provide technical assistance, as requested.	Review, analyze, and establish trends, as appropriate, from data submitted by DDEOC *Site Teams.*	Collect and forward all raw data for each ship under surveillance to the DDEOC Technical Group. Maintain *copies of all raw* data pages.		Submit requested data to the DDEOC Site Team. Include replaced parts data, if applicable to systems of interest.
DDEOC Technical Group and DDEOC Site Team Support	Submit budget requirements through the POM cycle to support DDEOC. Fund DDEOC Technical Group at PERA (CRUDES). Fund procurement of DDEOC Site *Team* test *equipment.* Fund assessment procedure development.	*Prepare POM issue* papers to support DDEOC. Provide program technical direction and management.	*Provide administrative* and technical support to the DDEOC Technical Group. Submit funding requirements to NAVSEA.	*Provide technical* direction to the DDEOC Site Teams. Identify needs for special DDEOC Site Team test equipment.	Submit quarterly funding requirements to TYCOM.	Fund support of DDEOC Site Team on a quarterly basis. Provide administrative support for DDEOC Site Teams. Provide special training for Site Team members, as required.	
DDEOC Site Team Visits	Promulgate overhaul schedules.	Provide liaison, as requested.	Provide liaison, as requested.	Recommend DDEOC Site Team visit priorities.	In coordination with the squadron, schedule assessment *procedures by* ship and implement schedule. Coordinate with ship, visit schedules, and requirements.	Provide ship availability schedule to DDEOC Site *Team.*	Coordinate with DDEOC Site Team, ship visit schedules, and requirements.

APPENDIX E

PLAN OF ACTION AND MILESTONES FOR
AN ENGINEERED OPERATING CYCLE PROGRAM

1. PLAN OF ACTION

The Plan of Action to initiate, develop, and implement an EOC program includes three phases:

- Initiation Phase - This phase consists of developing program POA&M and cost alternatives and performing preliminary engineering studies to establish the requirements of the Development Phase. The Initiation Study validates, by analysis, the feasibility of achieving program objectives and tentatively defines, for proposed ship classes, maintenance strategy and program constraints.

  The Initiation Phase usually lasts one year. An Initiation Study is completed within about 8 months, then reviewed (and revised as necessary) during months 9 through 12 so that a formal program can be established by the end of month 12.

- Development Phase - In this phase detailed ship system engineering work produces Ship Alteration and Repair Packages (if required), a Critical Equipment/System List, a Class Maintenance Plan, a program Management Plan, Material Condition Assessment Procedures, and Program Effectiveness Procedures.

  The Development Phase generally lasts two years in order for the results of engineering analyses to contribute to the first of each class's Baseline or Regular Overhauls (if required) before the ships enter the EOC program.

- Implementation Phase - During this phase, the EOC program is established and implemented, individual ships are introduced into the program, and an engineered maintenance management information system is developed. Also the new EOC program and its management are integrated with existing EOC programs and with other maintenance management programs.

The Implementation Phase includes Baseline and Regular Overhauls and overhaul analysis programs to establish ship baseline material condition. During this phase EOC Site Teams are established at the Type Commander level and the EOC Technical Group is activated at the related PERA to test and assess the material condition of ships' equipment. An ADP-assisted maintenance management system schedules maintenance from inputs of the Class Maintenance Plan, individual ships' CSMP, and the EOC Technical Group.

2. SCHEDULE AND MILESTONES

Table E-1 lists milestones for an EOC program. The item numbers key the actions to the EOC Development Program Master Network given in Figure E-1. The milestones called out represent the months into the program during which the actions are scheduled to begin.

Table E-1. EOC PROGRAM DEVELOPMENT MILESTONES

Item Number	Action	Milestone
1.	Commence EOC program	M-1
2.	Identify EOC ship classes	M-1
3.	Identify initial program objectives and constraints	M-1
4.	Commence gathering ship class data (MDS, CASREP, COSAL, PMS, FMP, etc.)	M-1
5.	Commence development of EOC ship class EOC maintenance concept	M-1
6.	Complete gathering ship class data	M-3
7.	Assess current ship status by class	M-4
8.	Define preliminary EOC maintenance strategy	M-4
9.	Estimate requirements of current program	M-5
10.	Estimate requirements for EOC program resources	M-5
11.	Conduct comparative analysis between current strategy and preliminary EOC strategy	M-6
12.	Complete initiation study of EOC strategy and feasibility	M-8
13.	Approve initiation study	M-12
14.	Enter resource requirements in Navy POM	M-12

(continued)

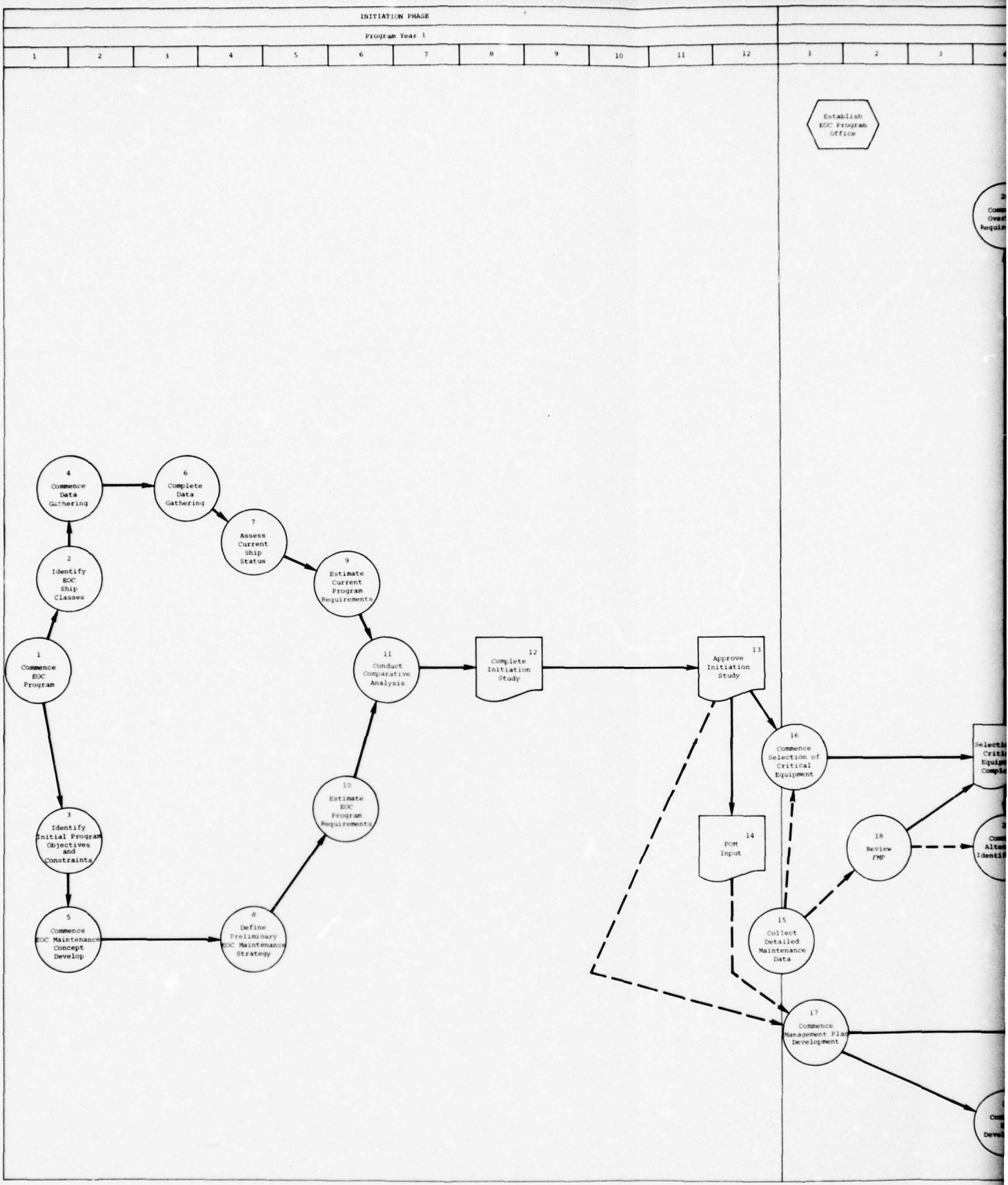
Table E-1. (continued)

Item Number	Action	Milestone
15.	Collect ship class detailed engineering maintenance data	M-13
16.	Commence selection of critical equipment and systems	M-13
17.	Commence development of EOC Management Plan	M-13
18.	Review Fleet Modernization Plan (FMP)	M-14
19.	Complete selection of critical equipments and systems	M-16
20.	Commence development of EOC class overhaul requirements	M-16
21.	Commence identification of alteration requirements	M-16
22.	Commence development of Management Information System (MIS)	M-16
23.	Complete identification of alteration requirements	M-18
24.	Refine requirements for engineering analyses	M-18
25.	Commence development of engineering analyses	M-18
26.	Complete development of EOC class OH requirements (preliminary)	M-19
27.	Commence development of Material Condition Assessment (MCA) procedures	M-21
28.	Complete development of EOC class OH requirements	M-22
29.	Commence development of Class Maintenance Plan (CMP)	M-23
30.	Commence development of CMP resources requirements	M-25
31.	Publish class OH SARP	M-26
32.	Commence development of Post-OH Analysis Program	M-28
33.	Complete CMP development (preliminary)	M-31

(continued)

Table E-1. (continued)

Item Number	Action	Milestone
34.	Implement first EOC OH Work Definition Conference (WDC)	M-32
35.	Complete class engineering analyses	M-32
36.	Complete development of CMP resource requirements	M-33
37.	Complete CMP	M-34
38.	Complete MIS Development	M-34
39.	Complete EOC Management Plan development	M-36
40.	Complete MCA procedures (preliminary) and initiate validation	M-36
41.	Complete Engineering Analysis follow-up	M-36
42.	Enter CMP items into MIS	M-36
43.	Complete development of Post-OH analysis program	M-36
44.	Estimate availability and shortfalls of resource requirements	M-37
45.	Publish EOC plan	M-37
46.	Commence pre-EOC overhauls	M-38
47.	Assess impact of resource requirement shortfalls	M-39
48.	Commence program to translate class plans to individual ship plans	M-39
49.	Complete validation of MCA procedures	M-40
50.	Complete program to translate class plans to individual ship plans	M-45


INITIATION PHASE
Program Year 1
1 2 3 4 5 6 7 8 9 10 11 12
1 2 3 4
Establish EOC Program Office
1 Commence EOC Program
2 Identify EOC Ship Classes
3 Identify Initial Program Objectives and Constraints
4 Commence Data Gathering
5 Commence EOC Maintenance Concept Develop
6 Complete Data Gathering
7 Assess Current Ship Status
8 Define Preliminary EOC Maintenance Strategy
9 Estimate Current Program Requirements
10 Estimate EOC Program Requirements
11 Conduct Comparative Analysis
12 Complete Initiation Study
13 Approve Initiation Study
14 POM Input
15 Collect Detailed Maintenance Data
16 Commence Selection of Critical Equipment
17 Commence Management Plan Development
18 Review FMP

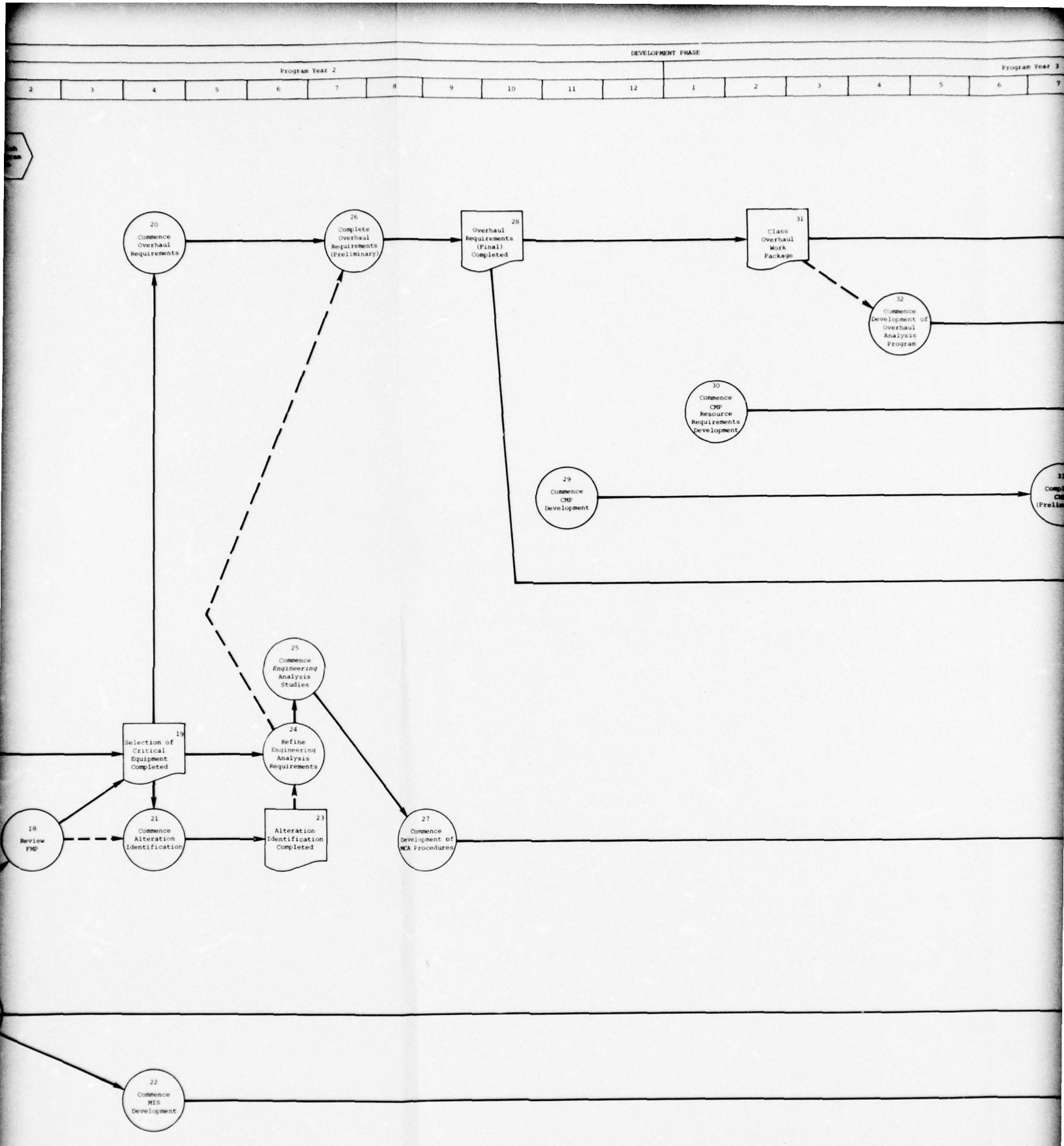
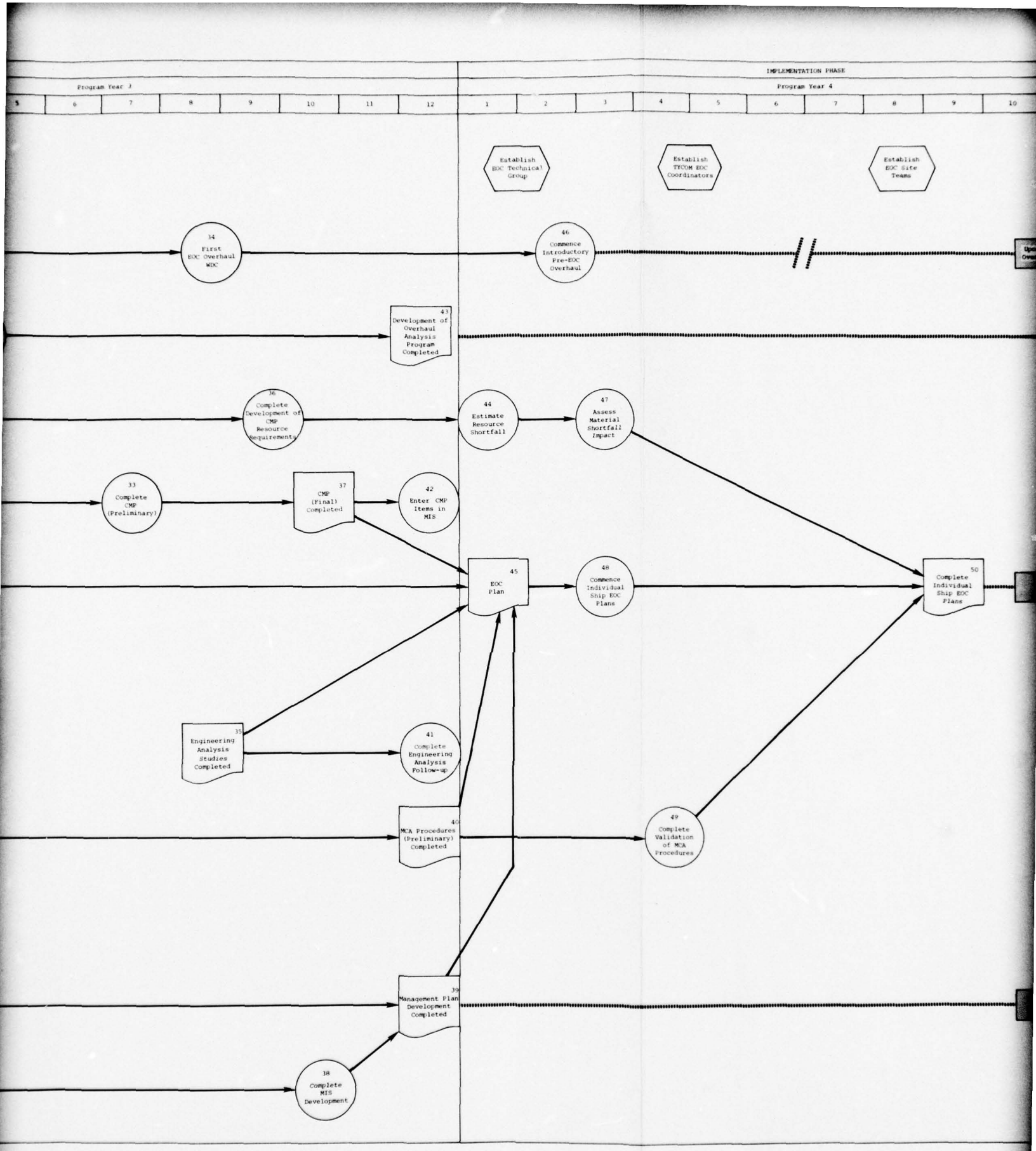
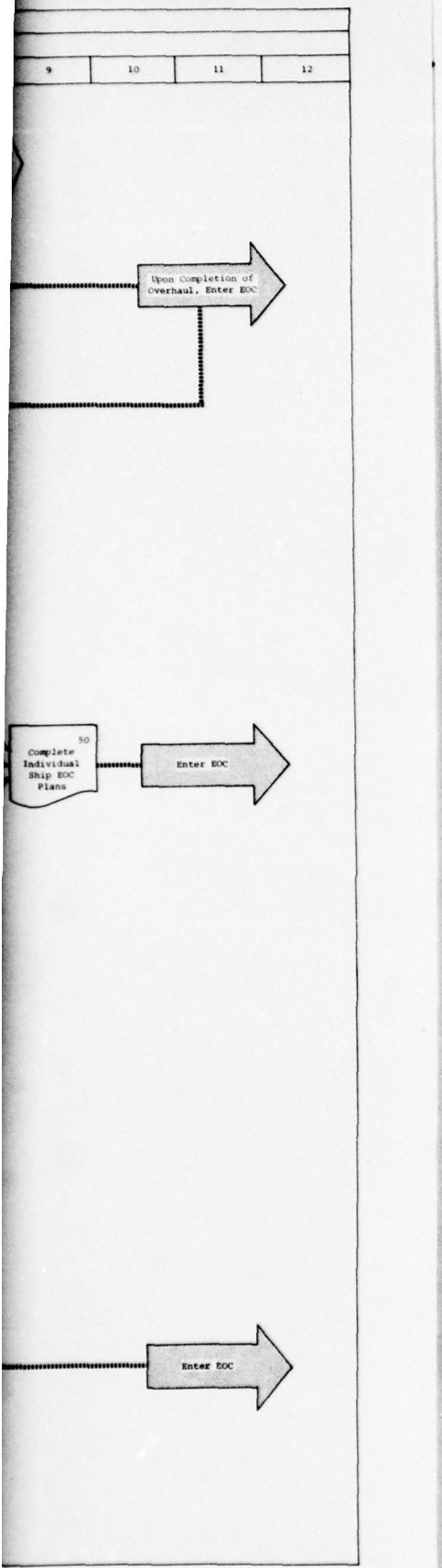


Figure E-1. EOC DEVELOPMENT PROGRAM MASTER NETWORK

2


IMPLEMENTATION PHASE
Program Year 3
Program Year 4
5
6
7
8
9
10
11
12
1
2
3
4
5
6
7
8
9
10
Establish EOC Technical Group
Establish TYCOM EOC Coordinators
Establish EOC Site Teams
34 First EOC Overhaul WDC
46 Commence Introductory Pre-EOC Overhaul
43 Development of Overhaul Analysis Program Completed
36 Complete Development of CMP Resource Requirements
44 Estimate Resource Shortfall
47 Assess Material Shortfall Impact
33 Complete CMP (Preliminary)
37 CMP (Final) Completed
42 Enter CMP Items in MIS
45 EOC Plan
48 Commence Individual Ship EOC Plans
50 Complete Individual Ship EOC Plans
35 Engineering Analysis Studies Completed
41 Complete Engineering Analysis Follow-up
40 MCA Procedures (Preliminary) Completed
49 Complete Validation of MCA Procedures
39 Management Plan Development Completed
38 Complete MIS Development

3


9
10
11
12
Upon Completion of Overhaul, Enter EOC
50
Complete Individual Ship EOC Plans
Enter EOC
Enter EOC

APPENDIX F

SYSTEM ENGINEERING ANALYSIS PROCEDURE

1. GENERAL

The System Engineering Analysis (SEA) is a process to identify known and potential problems that will have an EOC impact, to develop an economical and effective maintenance program to solve those problems, and to report the problems and solutions in a format compatible with other EOC program documents.

2. SYSTEM ENGINEERING ANALYSIS OVERVIEW

Figure F-1 illustrates the essential elements of the SEA process. The first step is to define precisely the system to be analyzed. This entails the identification of system configurations (normally denoted by specific sets of APLs). The next step is to identify problems that may affect the EOC program. This can be done through an examination of the system's maintenance history for those ship classes that have had sufficient operating experience to develop the necessary historical data. For ships of recent construction without historical data, system problems must be predicted from the design and engineering information that is available. Combining information such as Maintenance Engineering Analyses (MEAs), manufacturer's technical manuals, and experience with similar ships and equipments with engineering judgment will permit the identification of problems that are likely to occur during the Engineered Operating Cycle. These problems are divided into four categories: technological failures to be prevented or predicted, conditions to be improved by restorative maintenance modifications, conditions to be improved by Planned Maintenance System modifications, and maintenance burdens to be reduced.

The evaluation of alternative solutions is the next step. Decision processes are used to identify feasible alternative solutions and establish, to the maximum extent practical, the cost and effectiveness of each. Selection of a maintenance program to resolve the problems is based on the findings of this process. The results of the SEA consist of Integrated Logistic Support (ILS) changes, PMS changes, overhaul requirements, and inputs to other EOC program documents (e.g., CMP and Overhaul Analysis Program).

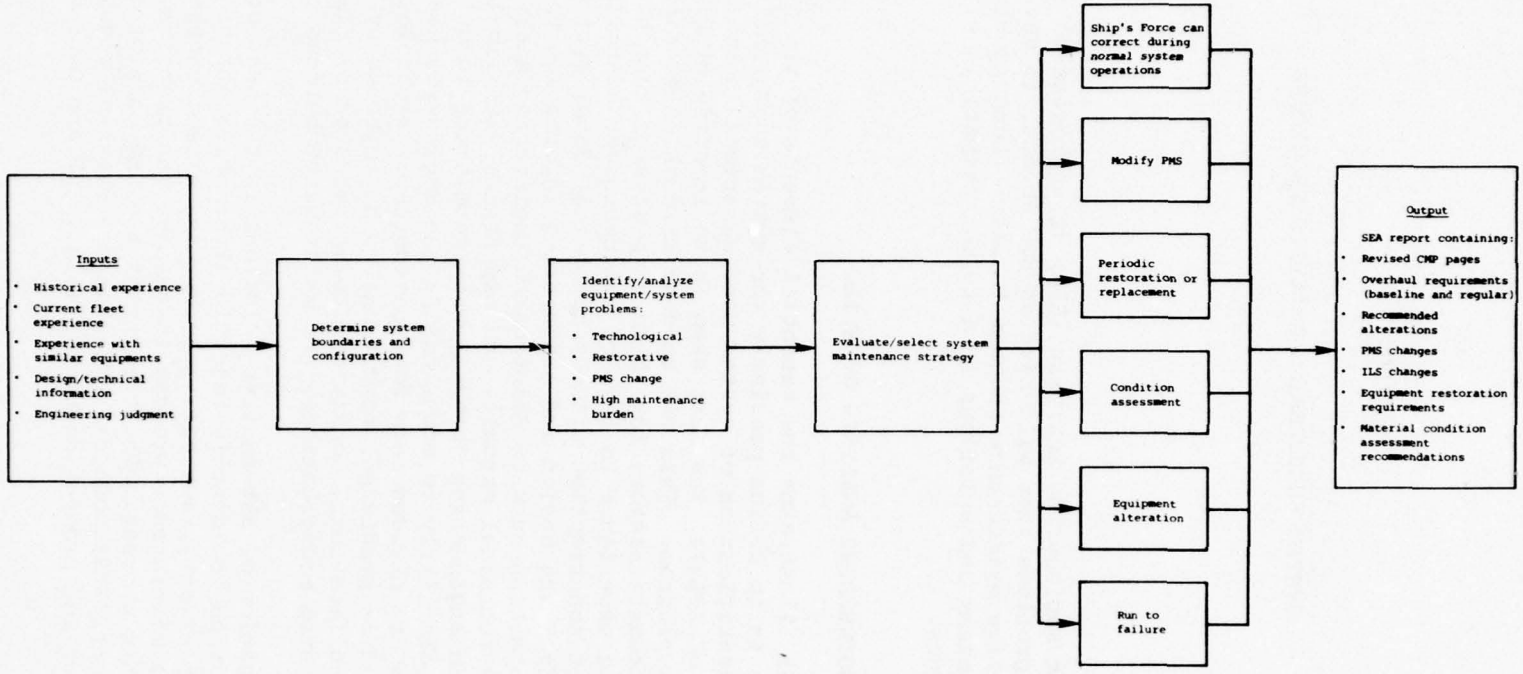


Figure F-1. SYSTEM ENGINEERING ANALYSIS PROCESS OVERVIEW

3. SEA ELEMENTS

The individual steps of the SEA process, as identified above, are discussed in detail in the following sections.

3.1 System Definition

In order to define the system in detail, reference may be made to Technical Manuals, the Type Commander's COSAL, SECAS reports, Ship Information Books, and other pertinent data sources. The configuration (i.e., the major components making up the system on individual ships within the class) must be specified by Allowance Parts List (APL) number or noun name. The configuration expected after the baseline overhaul should be determined by using lists of alterations and field changes and by discussions with NAVSEA and the Type Commander.

3.2 Problem Identification

The collected maintenance information is next examined to identify problems that will affect the EOC program. The processes to be used divide problems into four categories for identification and analysis: technological failures, conditions requiring restorative maintenance modifications, conditions requiring PMS changes, and high aggregate maintenance burdens. These problems must be identified and analyzed in a coordinated manner. The approach and method employed for each problem category may differ in detail, but findings in all categories must be reviewed collectively to ensure accurate and complete problem definition.

Findings should be documented to the extent necessary to establish that either the problem will not have an effect on the Engineered Operating Cycle, or that it will have an effect on the cycle and further analysis and evaluation are required.

3.2.1 Technological Problem Category

Technological problems are directly related to system and equipment material degradation or failure. There are two basic kinds of technical failures to be identified: those that have been experienced in the past and those that are expected to result from a longer operating cycle.

Not all past actions (i.e., degradation and failures) are of interest; random failures, requirements for minor upkeep, infrequent occurrences, and similar considerations are generally beyond the scope of analysis. Additionally, it is not practical to examine every action with the hope of preventing all failures. A screening procedure must select problems of potential EOC interest. Once technological problems have been identified from such sources as MDS and CASREP data, test and inspection reports, and other engineering design studies and have been screened, the optimum maintenance plan or strategy must be selected to correct them.

One approach that may be used in selecting a maintenance strategy is to consider the situation resulting from the problem and select the best alternative for preventing that situation. "Situation", as used here, means an occurrence which, if not prevented, will be an obstacle to the successful completion of the extended operating cycle. There are six possible maintenance strategies:

- Situation can be prevented by assessment and prediction made by Ship's Force from information obtainable during normal system operation.
- Situation can be prevented by modification of PMS practices.
- Situation can be prevented by periodic restoration or replacement.
- Situation can be prevented by assessment and prediction made by a specialized group from information especially collected and analyzed.
- Situation can be prevented by equipment alteration.
- Situation cannot be economically prevented (run to failure).

One or more of these alternatives should be selected as the means for prevention, depending on the complexity of the situation. As can be seen, the first question to be answered is "Can Ship's Force prediction prevent the situation?" The answer to this question is important because these predictions offer the most economical method of prevention. However, preventing some specific failures in this manner may not prevent the effect which caused the problem to be analyzed. For example, sudden, abnormally high noise from a bearing would normally be observed by Ship's Force and cause the equipment to be shut down. This action would prevent seizing of the shaft and further consequences of bearing failure. If, however, the bearing were a long-lead-time part, at least one consequence, a long system downtime, would be the same. No further alternatives should be considered if a Ship's Force prediction will prevent the situation.

As the decision process implies, the desired effect of each strategy alternative is the same, prevention of the situation. Hence, the decision between strategies is based primarily on estimates of cost including estimated resource and man-hour expenditures and long-lead-time aspects. Of course, the last alternative does not prevent the situation, so it would be selected only when it is clear that the other alternatives would be more costly.

3.2.2 Restorative Requirements Category

Restorative requirements refer to actions that need to be taken to bring an equipment or a part of it back to an "as accepted" or "like new" material condition. Actions presently scheduled for planned intervals of less than those planned for the EOC program under development, or which have been historically accomplished more frequently, are potential EOC problems. Sources which should be reviewed for selection of restorative actions as candidates for further analysis include:

- Planned Maintenance System (PMS) documents, paying particular attention to cyclic requirements
- Shipyard overhaul documents, for actions that have been performed as a result of inspection, test, or request, and actions designated as routine overhaul items
- Maintenance Data System records for maintenance actions that required outside assistance or were deferred because of a need for assistance (e.g., CSMP)
- ILS documents for the class (e.g., Plan for Maintenance)

An analytical method that may be used to determine actual restorative needs is a maintenance comparison of components that have been overhauled with those that have not and, if possible, an identification of particular piece part failures that have generated the need for overhaul. Preventive maintenance measures should first be considered, together with technological changes, as prospective methods of eliminating or reducing restorative requirements. If changes to preventive maintenance measures or technological changes will not provide the required problem solution, then renewal or replacement and on-condition renewal or replacement should be considered. The most economical strategy that can be accomplished within identified constraints should be selected.

3.2.3 PMS Change Requirements Category

Although PMS change requirements are a separate category of problems, their review is closely related to all other problem categories and should be coordinated with them. All system PMS requirements should be reviewed as potential problems, paying particular attention to the possibility of reducing open-and-inspect requirements and decreasing overall burden. The primary data sources for identification of PMS requirements are the PMS Maintenance Index Pages (MIPs) and Maintenance Requirement Cards (MRCs). Close liaison with the technical community is necessary to ensure that the most current MIPs and MRCs are used in the analysis.

Problems in the planned maintenance for a system are of three types: potentially damaging actions, potentially unnecessary or too frequent actions, and necessary actions not specified in written instructions.

3.2.4 Aggregate Burden Category

In extending an operating cycle, the overall resources needed to maintain a system must be considered. If greater and greater resources must be expended to support the system during the cycle, then the components requiring these increases must be identified and subjected to further individual analysis. Those components are EOC problems. Man-hours and parts usage are primary measures of aggregate problems. Other measures are the number of actions initiated within a time period and the number of outstanding deferrals at a particular time. MDS data are the principal source for the identification of aggregate problems; however, study of design data and liaison with the technical community and Fleet units are necessary to determine CSMP deferral levels experienced and other measures of aggregate problems.

Analysis of aggregate burden problems must be closely aligned with the identification and analysis of technological problems. If an aggregate problem can be attributed to a specific group of system components, those components should be subjected to technological analysis. If the aggregate problem cannot be solved in that manner, there are three alternative methods: assess the condition of the system or component and repair it as necessary, renew all or part of the system during the operating cycle, or renew it during overhaul periods.

During the entire SEA process and the development of recommended corrective actions, current and projected ship resources should be considered. Skill levels of technicians, ship manning, watch standing procedures, additional test equipment, and record keeping should not be changed unless a positive benefit sufficient to compensate for the change can be realized.

3.2.5 Documentation Requirements

The format of Systems Engineering Analysis reports should be flexible enough to accommodate the range of different systems being analyzed but should also have standard sections that allow the results to be incorporated in other EOC program elements. The most obvious example is the validation of the CMP. The revised pages of the CMP should be drafted as part of the System Engineering Analysis. Other standard sections of the System Engineering Analysis should include overhaul and availability requirements, recommended alterations, PMS changes, ILS changes, recommended restoration cycles, and recommendations regarding the development of material condition assessment procedures for monitoring the system. The format of these report sections must be carefully designed for compatibility between systems of totally different technologies.

APPENDIX G

SELECTION OF REPAIRABLE CHANGE-OUT EQUIPMENT

(To Be Provided)

APPENDIX H

MATERIAL CONDITION ASSESSMENT METHODS

1. GENERAL

System Engineering Analyses (SEA) identify the desirability and practicality of using Material Condition Assessment (MCA) methods to determine the condition of certain ship systems and equipment. MCA methods depend on criteria and procedures developed, in a large part, from existing MCA data and information. MCA methods are used by MCA Site Teams to acquire data for analysis.

A large quantity of system and component operational information is obtained from presently installed instrumentation. Additionally, for many systems, Ship's Force routinely monitor selected parameters and record data in watchstander logs, etc. Current PMS practices call for the monitoring of certain system parameters that could be gathered by MCA Site Teams and assessed in accordance with established standards and the data recorded. PMS, Total Ship Test Programs, Daily System Operation Tests (DSOTs), etc., should be used to the maximum in the development of limits for acceptable operational parameters.

2. PROCESS OVERVIEW

Development of Material Condition Assessment Methods can be divided into two distinct processes: criteria development and procedures development. Criteria development consists of the following five phases:

- Data Collection
- Parameter Identification
- Parameter Value Determination
- Parameter Recommendations
- Process Documentation

The procedures development process consists of the following five phases:

- Data Collection and Assessment Requirement Identification
- Assessment and Analysis Alternatives Evaluation

- Assessment and Data Analysis Procedure Selection
- Assessment Procedure and Analysis Technique Formulation and Validation
- Process Documentation

A detailed discussion of each of the two processes and their phases follows. Its purpose is to provide the developing activity with specific guidelines. Throughout the discussion, it must be understood that performance assessment and material condition assessment are closely related but not necessarily the same. Performance assessment refers to a measuring of the actual performance or "production" aspect of the system or component concerned; material condition assessment refers to an evaluation of the "material" aspects of the system or component concerned. Assuming standardized monitoring procedures are employed, degradation of performance can always be traced to some material degradation; however, detection of material degradation at the level required may not always be possible by performance assessment.

3. CONDITION ASSESSMENT CRITERIA DEVELOPMENT

This discussion will address the five phases contained in the criteria development process.

3.1 Data Collection

Data must be collected at the beginning and throughout the development of condition assessment criteria. The initial effort must be directed primarily toward identifying precise system assessment requirements and collecting system technical data. Previous engineering analysis of historical maintenance data has identified general assessment requirements for the particular ship system or its components and condition assessment as the best maintenance strategy to solve a problem affecting the program's Engineered Operating Cycle.

During the establishment of parameters and their specific upper and lower values, additional information must be continuously gathered from technical codes, Fleet units, maintenance activities, etc.

3.2 Parameter Identification

Two important considerations in the development of parameters are system level versus component level assessment and performance versus material condition assessment.

Requirements for both system level and component level assessment for a particular system may have been identified by the SEA, or it may have been determined in defining parameters that a particular problem has significant implications on both system and component levels. In these cases, it

may be necessary that parameters for both levels be determined. However, it is generally preferred that assessments be performed or aggregated to as high a level as is practical. Thus, the identification of parameters and their upper and lower levels should be directed to the highest system level that offers an adequate solution of the problem.

In defining assessment parameters, both the performance and material condition aspects of the particular assessment requirement should be considered. Performance assessment refers to the measurement of the production or control function of the system or component. Hence, for a fire pump, a measure of discharge flow and discharge pressure may suffice as a performance assessment parameter. While closely tied to performance assessment, material condition assessment refers to the material aspects of the item. The pressure and flow performance parameters may not indicate that the pump bearings are deteriorating and will affect the equipment. A measure of both performance and material may be required to accurately assess the fire pump, and parameters for each must, therefore, be identified.

3.3 Parameter Value Determination

Once performance and material condition parameters related to the specific problems of the system have been identified, appropriate upper and lower values must be defined for each parameter. Several initial constraints must be recognized in determining these limits. The most significant is the safety of Ship's Force and equipment. No value should be established that would result in a safety hazard to either personnel or machinery. Secondly, normal ships' missions must be considered in the determination of upper and lower limits. If the system is directly related to a ship mission (that is, if the system's unsatisfactory performance or material condition would cause a mission to be aborted), parameter values must be defined in agreement with mission requirements, even if the system would continue to operate below that level.

The upper performance and material condition values normally correspond to the "as-designed" system specifications. Upper limits will normally be given in the system technical manuals, design specifications, and Technical Repair Standards. In some cases, historical data may indicate that the system or component has been accepted as being in like-new condition at some level less than original design. Such a determination could be made from analysis of historical post-overhaul test results or technical discussions. In those cases, an upper level should be established on the basis of engineering evaluation and technical liaison. The level established must be commensurate with the goal of the item's assessment, prevention of the problem concerned.

Identifying the lower values of the system or component performance and material condition parameters is more complex than identifying the upper values. In many systems, little documentation exists stating what performance or material condition limits are considered acceptable. In

many cases, these levels must be identified on the basis of engineering evaluation and analysis of historical experience. The definition of performance and material condition parameters' lower levels must be approached in a coordinated manner. In many cases, they are interdependent and the levels established for minimum performance and minimum material condition must be in consonance. The lower material condition parameter value indicates a need for major corrective or restorative maintenance.

3.4 Parameter Recommendations

When parameters, with their upper and lower values, have been identified, recommendations must be made as to the ones that, on the basis of the knowledge obtained during their development, appear most useful in preventing the problem. The parameters for which assessment procedures will be defined should be finally selected during the course of the development of condition assessment procedures and be based on a cost/benefit analysis of alternatives. Recommendations made here facilitate this final selection effort.

3.5 Process Documentation

Accurate and precise documentation of all aspects of condition assessment criteria is mandatory. This documentation must contain the system boundaries diagram or tabulation developed in the SEA, highlighting components for which parameters have been identified. The information should include sources used, engineering evaluation processes employed, and the rationale for decisions made. Additional findings such as parameter measurement techniques identified, improved assessment data collection methods, parameters (including their upper and lower values) recommended for procedure development with corresponding rationale for recommendations, should be included when applicable.

4. CONDITION ASSESSMENT PROCEDURES DEVELOPMENT

As previously stated, the development of material condition assessment procedures will be undertaken in five phases following the identification of system or component assessment requirements and recommended parameters. The development of material condition assessment procedures requires the combination of information provided in the SEA and the first process of MCA methods development with additional information gained through technical liason into assessment procedures and assessment data analysis techniques which provide the optimum cost/benefit assessment alternative for the solution of the problem.

4.1 Data Collection and Assessment Requirement Identification

The initial phase to be undertaken is that of data collection. The data collected in the SEA and in the development of material condition assessment criteria serve as two of the principal sources for the development of material condition assessment procedures. The existing technical

expertise and documentation related to the system concerned provide a third and very significant data source. Effective liaison with NAVSEA Technical Codes, In-Service Engineering Activities (ISEAs), Operational Ships, Maintenance Activities and in some cases, equipment manufacturers and other civilian engineering activities should be established to ensure that assessment procedure development takes into account any on-going efforts that may affect the procedures.

4.2 Assessment and Analysis Alternatives Evaluation

In the development of assessment procedures and data analysis techniques, numerous alternatives must be evaluated. Initially, it must be decided whether system level or component level assessment, or both, are required. For systems or components having more than one assessment requirement or parameter identified, assessment procedures should be aggregated to the highest level commensurate with prevention of the problem concerned. It must be decided whether a new procedure is required, or if an existing procedure can be modified to meet the assessment requirements. The next step is to determine the type of procedures that could be developed for any given parameter. Three general categories are: operational monitoring, tests, and inspection. All aspects of the assessment requirement should be considered and actions included from one or more of these categories to provide optimum assessment of the system or component.

The frequency of all developed inspection and test procedures must then be determined. The procedure should be performed at the lowest frequency adequate to detect a change in the parameter sufficient for trend analysis and the prediction of major maintenance.

To be effective, assessment procedures must be performed in a standard and competent manner. The specialized activities available at various LORs must be evaluated to select the one best qualified to perform the procedure.

Alternative methods of data measurement and analysis techniques must be evaluated while the other factors presented in the preceeding paragraphs are being considered. These factors are significant in the determination of procedure frequency and activity to perform the procedure as well as in other facets or procedure development.

4.3 Assessment and Data Analysis Procedure Selection

When the various alternatives have been evaluated, the best combination to achieve the assessment procedures' objective should be selected. That combination should be selected on the basis of a cost/benefit analysis to determine the most benefit for the cost of the assessment procedure plus any unusual costs associated with the collection or analysis of assessment data, such as computerized analysis procedures. If, in the course of procedure development, it appears that the cost of a procedure to assess the recommended parameters is excessive, the EOC Program Office will have to decide whether to continue with those parameters or use others.

4.4 Assessment Procedure and Analysis Technique Formulation and Validation

The selected assessment procedures and assessment data analysis techniques should be formulated to develop, as a minimum, the following information:

- System and component involved
- Safety precautions
- Periodicity, man-hours required
- Accomplishment activity
- Special equipment or facilities required
- System or component setup (normal or special)
- Associated systems or components setup
- Detailed step-by-step procedure for obtaining assessment data
- Parameter values (upper and lower)
- Procedures to restore system or component to normal condition if special setup is required
- Format for recording assessment data

Each procedure should be prepared in Maintenance Requirement Card (MRC) format in accordance with the current revision of NAVSHIPS 0900-039-1010.

The test procedures should be validated on an EOC class test ship using installed shipboard equipments and giving the requisite attention to potential hazards to either personnel or equipment.

4.5 Process Documentation

Accurate and complete documentation of all aspects of assessment procedures and analysis development is mandatory. The following information should be documented:

- System assessment requirements for which procedures have been developed
- Clear identification of those portions of the system that will be assessed when the assessment Maintenance Requirement Cards (MRCs) are implemented
- Detailed discussion of the development of each procedure
- Discussion of the validation of the procedures and analysis techniques

APPENDIX I

ABBREVIATIONS AND ACRONYMS

This appendix lists abbreviations and acronyms commonly used in the EOC programs.

ACN	Activity Control Number
ACT	Active or Activity
ADMIN	Administrative
ADP	Automatic Data Processing
AEL	Allowance Equipage List
ALT	Alteration
AMT	Amalgamated Military/Technical Improvement Plan (MIP/TIP)
APL	Allowance Parts List
BOH	Baseline Overhaul
CASREP	Casualty Report
CM	Corrective Maintenance
CMP	Class Maintenance Plan
CNO	Chief of Naval Operations
CNM or CHNAVMAT	Chief of Naval Material
COH	Complex Overhaul
COMNAVSEASYSCOM	Commander, Naval Sea Systems Command
COMNAVSUPSYSCOM	Commander, Naval Supply Systems Command
COMSUBLANT	Commander, Submarine Forces, Atlantic Fleet
COMSUBPAC	Commander, Submarine Forces, Pacific Fleet
COMNAVSURFLANT	Commander, Naval Surface Forces, Atlantic Fleet
COSAL	Coordinated Shipboard Allowance List
CRUDES	Cruisers/Destroyers
CSMP	Current Ship's Maintenance Project
CSRR	Combat Systems Readiness Review
CSRT	Combat Systems Readiness Test
D ALT	Alteration authorized and funded by the TYCOM
DATC	Development and Training Center
DDEOC	Destroyer Engineered Operating Cycle
DOD	Department of Defense
DSOT	Daily System Operation Test
EIMB	Electronic Information Maintenance Bulletin
EIC	Equipment Identification Code
EOC	Engineered Operating Cycle (surface ships); Extended Operating Cycle (submarines)
EQUIP	Equipment
FAR	Functions, Assignments and Responsibilities

FIRM	Fleet Intensified Repairable Management
FLTCINC	Fleet Commander in Chief
FMAG	Fleet Maintenance Assistance Group
FMEA	Failure Modes and Effects Analysis
FMP	Fleet Modernization Program or Plan
FMSO	Fleet Material Support Office
FORSTAT	Force Status
FSC	Federal Stock Class
FSN	Federal Stock Number
FY	Fiscal Year
GWSRP	Gun Weapon System Replacement Program
HM&E	Hull, Mechanical, and Electrical
ID	Identification
ILS	Integrated Logistic Support
IMA	Intermediate Maintenance Activity
IMMP	Integrated Maintenance and Modernization Planning
IMMS	Intermediate Maintenance Management System
Indust. Act.	Industrial Activity
INSURV	Inspection and Survey
ISEA	In-Service Engineering Activity
JCN	Job Control Number
JSN	Job Sequence Number
K ALT	An alteration authorized and funded by NAVSEA
LLT	Long Lead Time
LLTM	Long Lead Time Material, with a delivery time in excess of 60 days
LOE	Light-Off Examination
LOR	Level of Repair or maintenance level
LSA	Logistic Support Analysis
MAINT	Maintenance
MCA	Material Condition Assessment
MCS	Material Condition Standard
MDS	Maintenance Data System
MEA	Maintenance Engineering Analysis
MIAPL	Master Index of APLs

MIL-SPEC	Military Specification
MIL-STD	Military Standard
MIP	Maintenance Index Page (3-M/PMS) or Military Improvement Plan (FMP)
MIS	Management Information System
MOE	Measure of Effectiveness
MOR	Method of Repair
Mos	Months
MRC	Maintenance Requirement Card
MSO or MSOD	Maintenance Support Office Department
NAVCOMPT	Comptroller of the Navy
NAVELEX	Naval Electroncis Systems Command
NAVMAT	Naval Material Command
NAVSEA	Naval Sea Systems Command
NAVSEC	Naval Ship Engineering Center
NAVSUPSYSCOM or NAVSUP	Naval Supply Systems Command
NEOCS	Navy Enlisted Occupation Classification System
NIIN	National Item Identification Number
NMDL	Navy Management Data List
NSN	National Stock Number
NSTM	Naval Ship Technical Manual
O&MN	Operations and Maintenance, Navy
OBRP	On Board Repair Parts
OIP	Ordinance Improvement Plan
OPNAV	Office of the Chief of Naval Operations
OPPE	Operating Propulsion Plant Examination
OPTAR	Operating Target
OrdAlt	Ordance Alteration
OSO	Office of the Secretary of Defense
OVHL (or OH)	Overhaul
PEB	Propulsion Examining Board
PEB/LOE	Propulsion Examining Board/Light-Off Examination

PERA	Planning and Engineering for Repairs and Alterations: (ASC) Amphibious Ships and Craft, Norfolk NSYD (CRUDES) Cruisers/Destroyers, Philadelphia NSYD (CSS) Combat Support Ships, NAVSEA Industrial Support Office (NISO) San Francisco (CV) Aircraft Carriers, etc., Puget Sound NSYD (SS) Submarines, Portsmouth NSYD
PM	Preventive Maintenance
PMDO	Planned Maintenance during Overhaul
PMS	Planned Maintenance System
POA&M	Plan of Action and Milestones
POM	Program Objectives Memorandum
POT&I	Pre-Overhaul Test and Inspection
psi	pounds per square inch
R&D	Research and Development
R&M	Reliability and Maintainability
RAV	Restricted Availability
RCM	Reliability Centered Maintenance
RDT&E	Research, Development, Test and Evaluation
REFTRA	Refresher Training
RMA	Reliability, Maintainability, and Availability
RMMS	Repair Maintenance Management System
ROH	Regular Overhaul
ROV	Repair of Vessel
SAMIS	Ship Alteration Management Information System
SARP	Ship Alteration and Repair Package
SAT	Ship Assistance Team
SEA	Systems Engineering Analysis
SECAS	Ships Equipment (Electronic) Configuration Accounting System
SEOC	Submarine Extended Operating Cycle
SFOMS	Ship's Force Overhaul Management System
SHAPM	Ship Acquisition Project Manager
ShipAlt	Ship Alteration
SIB	Ship Information Book
SIMA	Shore-Based Intermediate Maintenance Activity
SLM	Ship Logistics Manager

SMMS	System Maintenance Monitoring and Support
SMMSO	System Maintenance Monitoring and Support Office
SNSL	Standard Navy Stock List
SOAP	Supply Operations Assistance Program
SOH	Supply Overhaul
SPCC	Ships Parts Control Center
SRA	Selected Restricted Availability
SSDI	Ship Systems Definition and Index
SSIP	Ship Support Improvement Project
SUBSAFE	Submarine Safety Program
SUPSHIP	Supervisor of Shipbuilding, Conversion, and Repair
SURFLANT	Surface Fleet, Atlantic
SURFPAC	Surface Fleet, Pacific
SWABS	Ship Work Authorization Boundary System
SWBS	Ship Work Breakdown Structure
SYSCOM	System Command
T&C	Test and Certification
TAV	Technical Availability
TIP	Technical Improvement Plan (Program)
TLR	Top Level Requirement
TLS	Top Level Specification
TM	Technical Manual
TMMP	Trident Maintenance Management Program
TOR	Timing of Repair
TPMAP	Trident Performance Monitoring and Analysis Program
TRS	Technical Repair Standard
TSTP	Total Ship Test Program
TYCOM	Type Commander
UIC	Unit Identification Code
WBS	Work Breakdown Structure
WDC	Work Definition Conference
WSF	Weapon System File
3-M	Maintenance and Material Management

APPENDIX J

DEFINITIONS

This appendix provides definitions of the DDEOC program terms.

Allocation - In budgeting, the process of making appropriate funds available for obligation below the NAVCOMPT level; in general, the process of distributing or making resources available for use.

Alteration - Any change in the hull, machinery, equipment, or fittings that involves a change in design, materials, number, location, or relationship of an assembly's component parts whether the change is separate from, incidental to, or in conjunction with repairs. Categories of alterations are:

- Approved Alteration - Alteration approved for accomplishment, but funding and year of accomplishment not identified.
- Authorized Alteration - Alteration approved for accomplishment with funding and year of accomplishment identified.
- Electronic Field Changes - Any modifications or alterations made to electronic equipment after delivery to the government.
- Military Alteration - An alteration that changes or improves the military characteristics of a ship (CNO-managed).
- Ordnance Alteration (OrdAlt) - Alteration to ordnance equipment under the technical cognizance of NAVSEA and composed of:
  - Ordnance Alteration Instruction - Technical document containing instructions, drawings, test procedure, and directions to accomplish a material change, modification, repositioning, or alteration in the physical appearance of an installation of different parts in subassemblies, assemblies, or components in a weapon or system. Technical publication changes are supplied as part of that data package.

Alterations (continued)

- •• OrdAlt Kit - All the material and documentation required to perform an OrdAlt and may include materials and documentation necessary for testing, operating, and maintaining the equipment after alteration. OrdAlt Kits include complete hardware, special tools if required, and a copy of the OrdAlt instruction. In some cases a conjunctive ShipAlt may be required with an OrdAlt.

- Programmed Alteration - An alteration that is listed for accomplishment in one of the fiscal years in the Fleet Modernization Program (FMP).

- Technical Alteration - An alteration that affects safety, maintainability, reliability, or system performance (CHNAVMAT-managed).

- Title D Alteration - An alteration equivalent to a repair, approved by NAVSEA. Title D ship alterations are authorized by the Type Commander and funded under O&M,N as operating expenses.

- Title K Alteration - An alteration authorized for accomplishment through the FMP and usually requiring special program material. It is accomplished by industrial activities and approved by CNO through the FMP process.

- Ship Alteration (ShipAlt) - Any change in the hull machinery, equipment, or fittings which involves change in design, materials, number, location, or relationship of the component parts of an assembly. ShipAlts are classified by title, such as Title A alteration.

- Unprogrammed Alteration - An alteration not listed for accomplishment under one of the fiscal years in the FMP and listed in the "Unprogrammed" section in the FMP.

Allowance Equipage List (AEL) - A document prepared for various categories of equipage (tools, etc.) or for operating systems. It includes items required for the operation of the system or repair parts for support of the system. Generally, AEL items are Operating Space Items in the custody of department heads.

Allowance Parts List (APL) - A document prepared for individual equipments and components listing their associated repair parts and corresponding allowance and maintenance information.

Amphibious Engineered Operating Cycle (PEOC) - An operating cycle for amphibious ships consisting of periods of overseas deployment and scheduled periods of maintenance whose "duration"/"interval" is in the process of being determined. Engineering analyses are the basis for defining maintenance to be performed during periods of shore-based maintenance availabilities.

Appropriated Funds - Funds appropriated for obligation in specific areas, such as funds for overhaul (ROH), availabilities (RAV/TAV), repairs (ROV), or modernization (FMP).

Availability - Assignment of a ship to a repair activity for the purpose of accomplishing repairs or performing maintenance. Specific types of availabilities assigned ships are:

- Alongside (Restricted) Availabilities - Scheduled availabilities during which IMA personnel work on board the customer ship. Ships assigned alongside availabilities are berthed either physically alongside or in the immediate vicinity of the IMA. Availabilities of this nature with DATC/FMAG are referred to as "restricted" availabilities and are at least 15 consecutive work days in duration.

- Emergent (Emergency) Availabilities - Those unscheduled availabilities assigned for voyage repairs or for the correction of CASREPs that significantly impair operational readiness. Ships assigned an emergency availability are berthed either physically alongside or in the immediate vicinity of the IMA.

- Restricted Availability (RAV) - An availability assigned for the accomplishment of specific items of work by an industrial activity with the ship present, during which time the ship is rendered incapable of fully performing its assigned missions and tasks. Restricted availabilities are assigned by Type Commanders.

- Selected Restricted Availability (SRA) - An availability scheduled by the Chief of Naval Operations to permit effective advance planning so that time and funds may be more effectively utilized. In the DDEOC program, two SRAs are assigned during the operating cycle between regular overhauls.

- Ship-to-Shop Availabilities - Those unscheduled availabilities assigned for significant repairs not of an emergency nature and that do not normally require IMA personnel to work on board the customer ship. A ship-to-shop availability is automatically assigned to all U.S. Navy ships in port with the IMA. To control IMA loading when more than one IMA is present, the TYCOM will control the designation of ship-to-shop availabilities.

- Technical Availability (TAV) - An availability for the accomplishment of specific items of work by a repair activity, normally with the ship not present, during which the ship's ability to fully perform its assigned mission and tasks is not affected.

- Tender Availabilities - Scheduled alongside availabilities where the ship is assigned to a tender (AD, AR, etc.)-type IMA.

Class Maintenance Plan - A document that identifies and schedules the periodic required maintenance and repairs of specific ship classes at times of overhaul and during their operating cycles.

Classes of Ship Systems and Component Overhauls

- Class A - Work that requires such overhaul or repairs, modifications, field changes, OrdAlts or ShipAlts as will sustain or improve the operating and performance characteristics of the system, subsystem, or component being repaired or altered to meet the "most recent" design and technical specifications for that item. It is intended that the end product be in "like new" condition in appearance as well as in operation and performance. All manufacturer's and technical manual performance standards and specifications, unless superseded by proper authority, will be met, as will all technical documentation. The repair activity will demonstrate that the end product successfully meets all performance criteria specified by the governing specifications. Defining an overhaul as Class "A" means that all actions required to meet the definition are authorized. The definition is applicable to all components, subsystems, and systems whether machinery, electrical, hull, electronics, or weapons, without regard to equipment cost, size, or complexity. Thus, a Class "A" overhaul of a 10-horsepower motor is just as much Class "A" as that of a radar set or a boiler, although the demands on resources differ greatly.

- Class B - Work that requires such overhaul or repairs as will restore the operating and performance characteristics of a system, subsystem, or component to its "original" design and technical specifications. If it is required to restore the operating and performance characteristics of an item to other than its original design and technical specifications, it must be so specified and the performance criteria defined. ShipAlts, OrdAlts, field changes, and modifications, even if applicable, are not to be accomplished unless specified by the customer. Maintenance adjustment and calibration routines specified by the applicable instruction manual, unless superseded by authority, are required. The repair activity will demonstrate that the end product successfully meets all performance criteria specified by the governing specifications.

- Class C - Repair work on a system, subsystem, or component specified by the work request or that work required to correct the particular deficiencies or malfunctions specified by the customer. The repair activity must demonstrate that the work requested has been accomplished or that the conditions or malfunctions described have been corrected, but the repairing activity has no responsibility for the repair or proper operation of the associated components of the equipment or for the operation of the system as a whole.

Classes of Ship Systems and Component Overhauls (continued)

- Class D - Work associated with the "Open, Inspect, and Report" type of work request in which the customer cannot be specific about what is or may be wrong with the item. This class of work is intended to be diagnostic and thus may require various tests followed by inspection, to assist in a complete diagnosis. The repair activity will report findings, recommendations, and cost estimates to the customer for authorization prior to any repair work. When requested by the customer, minor repairs and adjustments may be accomplished without prior authorization to the extent specified.

- Class E - Work required to incorporate all alterations and modifications specified for a designated system, subsystem, or component. The repair activity will demonstrate the successful checkout of the work accomplished to assure compliance with the performance standards established for the modification only to the extent of the work performed. When required by the customer, the repair activity will conduct system tests to prove system operability through affected interfaces. Repairs, if any, are minor.

Combat System Readiness Review (CSRR) - A series of tests of ship combat systems conducted 90-120 days prior to a major deployment to ensure the operability of systems and their related equipment.

Combat Systems Readiness Test (CSRT) - A test conducted on a specific system or subsystem as part of a combat systems readiness review.

Coordinated Shipboard Allowance List (COSAL) - An authoritative document which defines a ship's configuration and its supply support requirements by listing:

- Configuration:
  - Part I
    - Summary of effective APLs/AELs
    - Listing of APL/AELs by Nomenclature Description
    - Listing of APLs/AELs by System Usage
    - Listing of APLs/AELs to EIC Relationships
    - Listing of APLs/AELs to WBS Relationships
  - Part II - Technically identifies each equipment/component by providing nameplate data, parts identification and supply support criteria for APLs/AELs included in Part I.
- Supply Support:
  - Part III - Provides a listing of On Board Repair Parts (OBRPs), Equipage (Operating Space Items) and consumables required to achieve maximum self-supporting capability during extended operation.

Corrective Maintenance (CM) - The sum of those actions required to restore equipment to an operational condition within predetermined tolerance limits.

Critical Equipments/Systems List - A listing of the equipments and systems that represent a significant maintenance problem in relation to program objectives and constraints.

Current Ship's Maintenance Project (CSMP) - Provides shipboard maintenance managers with a consolidated list of deferred corrective maintenance with which to manage and control its accomplishment. The CSMP is the basic 3-M management tool used on board ship.

Deployment - The routine extended cruise of a ship to waters remote from home port. When deployed, a ship is usually under the command of an area operational commander.

EOC Program Office - A program office established to develop and implement the plans and procedures needed to satisfactorily maintain certain ship classes while in the EOC.

EOC Site Team - A team composed of military personnel, established at major EOC ship home ports, that will either conduct or assist Ship's Force in the performance of EOC assessment procedures.

EOC Technical Group - A group of engineers that provides dedicated technical support to the EOC program. The EOC Technical Group may be an independent organization or it may be a subelement of a larger organization. In the DDEOC program, the Technical Group is a part of PERA(CRUDES).

Destroyer Engineered Operating Cycle (DDEOC) - An operating cycle for destroyers (about five years long) consisting of three periods of overseas deployment and scheduled periods of maintenance. Engineering analyses are the basis for defining maintenance to be performed during periods of shore-based maintenance availabilities.

Development and Training Center (DATC) - A fully equipped shore-based intermediate-level maintenance activity staffed by Navy personnel of various ratings that provides industrial-type maintenance support for local ships.

Electronic Field Change - Any modifications or alterations made to electronic equipment after delivery to the Government.

Equipment Identification Code (EIC) - A four-digit alpha-numeric code that identifies the system or subsystem and equipment associated with a maintenance action or repair part usage.

Failure Modes and Effects Analysis - A systematic examination of all components of the system or equipment to identify their function, the manner in which they might fail, and the effects of failure on the overall system in relation to mission performance and personnel safety.

Feedback - The return to the input of a part of the output of a process, for purposes of producing changes that improve the performance of the process.

Fiscal Year (FY) - An accounting period of twelve months beginning on 1 October each calendar year (starting calendar year 1976).

Fleet Maintenance Assistance Group (FMAG) - A team of Navy enlisted personnel of various ratings located at major Navy ports to provide repair and maintenance assistance to local ships requesting their services.

Fleet Modernization Program (FMP) - The process that installs alterations on U.S. Navy ships, both active and reserve, and provides a funding base and alterations planning and support.

Functional Organization Chart - A graphic presentation of the functions of an organization by organizational units, with relationships indicated and a description of the functions included.

Inspection and Survey (INSURV) - An inspection team made up of Naval Officers whose responsibility is to periodically inspect Navy ships, both new and operational, and assess their material condition and state of maintenance for initial or continued operational service.

Level of Repair - The level of maintenance activity most likely to possess the necessary skill levels to achieve satisfactory repairs, i.e., depot, intermediate, or organizational level. Synonymous with level of maintenance.

Long Lead Time - Delivery time for material in excess of 60 days.

Maintainability - A quality of the combined features and characteristics of equipment and system design and maintenance resource planning that contributes to the speed, economy, ease, and accuracy with which the system can be kept in or restored to specified operating condition in the planned maintenance environment.

Maintenance - The function of sustaining material in an operational status, restoring it to a serviceable condition, or updating and upgrading its functional utility through modification. Maintenance consists of the following:

- All actions taken to keep material in a serviceable condition or to restore it to serviceability. It includes inspection, testing, servicing, classification as to serviceability, repair, rebuilding, and reclamation.
- All supply and repair action taken to keep equipment in condition to carry out its mission.
- The routine recurring work required to keep equipment in condition to carry out its mission.

Maintenance Burden - The average cost of maintaining a system or item of equipment over a period of time. Cost is measured in terms of manpower or dollars or both.

Maintenance Critical Equipments - Equipments that historically either have established themselves as essential for the successful completion of the mission of the ship or have demonstrated themselves to be significant maintenance problems.

Maintenance Engineering - That activity of equipment maintenance that develops concepts, criteria, and technical requirements during the conceptual and acquisition phases to be applied and maintained during the operational phase to assure timely, adequate, and economic maintenance support of weapons and equipments.

Maintenance Engineering Management - The process of planning, organizing, staffing, directing, and controlling those maintenance resources engaged in the engineering and technical support of equipment maintenance.

Maintenance Levels - The three levels of ship maintenance are:

- Organizational (Shipboard) Maintenance - Maintenance that is the responsibility of and performed by the Ship's Force on assigned equipment.

- Intermediate Maintenance - Maintenance normally performed by Navy personnel on tenders, repair ships, and aircraft carriers; Fleet support bases; and SIMAs (FMAGs). It normally consists of calibration, repair, or replacement of damaged or unserviceable parts, components, or assemblies; the emergency manufacture of unavailable parts; and provision of technical assistance to using organizations. Additional Shore IMAs (SIMAs) are programmed for operational use in the early 1980s to augment existing facilities.

- Depot (Shipyard) Maintenance - Maintenance performed by industrial activities on material requiring major overhaul or a complete rebuild of parts, assemblies, subassemblies, and end items, including parts manufacture, modification, testing, and reclamation as required. This is normally accomplished on ships at commercial facilities or Naval shipyards, including ship repair facilities, during restricted availabilities, technical availabilities, and regular overhauls.

Maintenance Management - The process of planning, budgeting, coordinating, scheduling, and controlling the maintenance, repair, and alteration activities for a ship or unit and its various on-board systems and equipments.

Maintenance Resources - Consists of personnel, materials, tools and equipment, facilities, technical data, funds, and time provided to carry out the equipment maintenance mission.

Material Condition Assessment (MCA) - A means of determining and projecting the material condition of an item based upon periodic observations of performance, operating, or maintenance parameters.

Material Condition Standard (MCS) - The condition characteristics and performance criteria of items (system, subsystem, or equipment) that produce acceptable operation.

Material Readiness - A measure of the equipment (or system) readiness of a ship to go to sea and perform its assigned missions. It is also a measure of a ship's ability to maintain high operational availability.

Military Improvement Plan (MIP) - A priority listing of desired and approved changes in the military characteristics of ships, promulgated by CNO for guidance of programming, preparing budget requests, monitoring design work, and authorizing procurement and installations during particular fiscal years. It lists in order of priority the applicable project number, brief description, types of ships in which installation is planned, and other pertinent information.

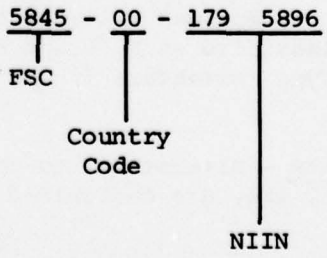
Mission Critical - Items whose failure would cause significant or total degradation of mission capability.

3-M (Maintenance and Material Management) System - Provides for managing maintenance and maintenance support in a manner that will ensure maximum equipment operational readiness. OPNAVINST 4790.4 prescribes policies and procedures for the installation and operation of this system on board ship. The 3-M System consists of two subsystems:

- Planned Maintenance System (PMS) - Provides each ship with a simple standard means for planning, scheduling, controlling, and performing planned (preventive) maintenance on all equipment.

- Maintenance Data System (MDS) - Provides a means by which maintenance personnel report deferred and completed maintenance actions for use in maintenance planning and maintenance support actions by various levels and areas of management throughout the Navy.

National Stock Number (NSN) - A 13-digit number that uniquely identifies an item of supply. It is made up of a four-digit Federal Supply Class (FSC) that describes the general commodity nature of the item, a two-digit country code, and a sequentially assigned National Item Identification Number (NIIN).



Navy Management Data List (NMDL) - A catalog of all Navy interest National Stock Numbers with their associated unit prices, maintenance codes, cross reference data, and units of issue.

Operational Availability - The fraction of time a ship is available for conducting normal operations. Operational availability (Ao) can be defined as:

$$Ao = \frac{\text{Operating Time}}{\text{Operating Time + Downtime}}$$

Overhaul Cycle - Period starting with the completion of one overhaul and ending with the completion of the next overhaul.

Overhaul Work - The work that must be accomplished for the ship to operate satisfactorily during the operating cycle following the overhaul (and before the next overhaul). The work required for a thorough overhaul encompasses:

- Routine Corrective Maintenance - The repair or overhaul of equipments or systems that are defective, malfunctioning, unsafe, or exhibiting sufficient signs of weakness, old age, etc., that it is reasonably predictable that, unless repaired, overhauled, or replaced, they will not operate trouble-free or will become unsafe for the next operating cycle.

- Insurance Maintenance - The overhaul of mission-essential equipments or systems to prevent their untimely failure during the next operating cycle. The likelihood of failure is established by reasonable engineering predictions or failure analysis study of similar equipments.

- Habitability Defect Correction Work - The correction of habitability defects that constitute substandard health, sanitary, or living conditions. Work requests are prepared for only those items deemed cost-effective with reference to the improvement gained, and assigned priorities and accomplishing activities in the same manner as other overhaul work. However, an extract of all habitability work will be prepared and reviewed separately prior to final determination of the overhaul work package.

- Technical Improvements - Alterations that provide a significant improvement in equipment performance, personnel safety, reduced maintenance costs, or improved reliability. These technical improvements are classified as K, D,and F Alts and are programmed in advance by the Type Commanders in conjunction with NAVSEA and CNO.

- Military Improvements - Alterations to the ship's military characteristics. As such, they are designated as Title K Alts and funded by NAVSEA.

Overhauls - A major ship availability established for general maintenance and alterations at a Naval shipyard or other shore-based depot-level repair activity. During this period, the ship generally undergoes the installation of alterations and modifications to update its capabilities and large-scale maintenance that cannot be undertaken at other times. The categories of overhauls are:

- Baseline Overhaul (BOH) - The performance of all maintenance actions necessary to restore a ship's systems, subsystems, and equipments to a condition where, with a well-engineered and executed maintenance program, they can be expected to perform satisfactorily over an extended operating cycle.

- Regular Overhaul (ROH) - An availability for the accomplishment of general repairs and alterations at a Naval shipyard or other shore-based repair activity, normally scheduled in advance and in accordance with an established cycle.

- Complex Overhaul (COH) - An overhaul that, due to money, time or manpower constraints or the complexity or interrelationship of the various ship subsystems affected by the overhaul work packages, requires coordinated and extensive management of both the planning and industrial phases of the overhaul in order to provide a high level of confidence that the overhaul can be satisfactorily completed.

- Supply Overhaul (SOH) - The work involved in improving the material readiness of a ship by bringing storeroom repair part inventories up to the level prescribed in updated allowance and load lists or to the endurance level prescribed by appropriate fleet authority. Attainment of this broad objective requires the successful conduct of many separate but related actions, all of which are appropriately part of the supply overhaul as conducted under the Supply Operations Assistance Program (SOAP).

PERA (Planning and Engineering for Repairs and Alterations) - A program for improving the advance planning, integration, and control procedures associated with overhaul. The primary objective of the PERA Program is to provide intensive management for the accomplishment of effective, efficient, orderly, and timely ship overhauls. There are currently five PERAs:

- PERA (SS) - Submarine, located at Portsmouth NAVSHIPYD
- PERA (CV) - Aircraft carriers and other aviation-type ships, located at Puget Sound NAVSHIPYD

PERA (Planning and Engineering for Repairs and Alterations) (continued)

- PERA (CRUDES) - Cruiser/Destroyers, located at Philadelphia NAVSHIPYD
- PERA (CSS) - Combatant Support Ships, located at NAVSEA Industrial Support Office (NISO), San Francisco
- PERA (ASC) - Amphibious Ships and Craft, located at Norfolk NAVSHIPYD

The PERA Offices, as extensions of the NAVSEA Ship Logistic Divisions, integrate the requirements of the various System and Type Commands and manage the planning and engineering efforts for overhauls of assigned ship types and vital interrelated programs pertaining thereto. On the basis of ship modernization planning documents they assist the Ship Logistic Divisions and Type Commanders in the development of class modernization and maintenance packages for assigned ships. The PERAs develop a complete and integrated ship overhaul planning work package that is usable by an overhauling activity with minimum translation and minimum additional planning.

Performance Effectiveness - A measure of the capability to provide most efficiently the required operational functions on a continuous combat-readiness basis.

Performance Evaluation - The analysis in terms of initial objectives and estimates of accomplishments, using an automatic data processing system to provide information on operating experience and to identify corrective actions required, if any. Usually made on-site.

Planned Maintenance - Maintenance defined by the Navy's Planned Maintenance System. Includes preventive maintenance (e.g., changing oil) and other activities and inspections that do not improve or restore equipment but do indicate the condition of the equipment. Planned Maintenance has been defined as "maintenance that has been systematically prearranged".

POM Years - A five-year fiscal year period for which funds are programmed. The first POM year is the fiscal year following the budget year.

Pre-Overhaul Test and Inspection (POT&I) - Performed to determine overhaul and RAV work requirements. It is necessary for some equipment to undergo a test in order for technicians to determine its repair requirements. A simple inspection by technicians, supplemented by discussion with operating personnel, is usually sufficient to determine such requirements. POT&I will be limited to equipments or systems for which tests will yield significant and not otherwise available information for determining overhaul work requirements. POT&I will not normally be conducted on machinery known to require overhaul or that is determined to fall into the "essential" or "insurance" categories.

Preventive Maintenance - Maintenance that improves the performance of an equipment and prevents incipient failures. The OPNAV definition is "the sum of those actions performed on operational equipment that contribute to uninterrupted operation of equipment within design characteristics".

Process Chart or Diagram - A graphic representation of the major steps of work in process. The illustrative symbols may represent documents, machines, or actions taken during the process. Concentration is on where or who does what, rather than how it is to be done.

Program Objectives Memorandum - A document which displays total Navy requirements for a seven-year period. Submitted annually to SECDEF for use in structuring the annual budget.

Propulsion Examining Board/Light-Off Examination (PEB/LOE) - Examination established by the CNO to ensure that strict adherence to 1200-psi popul-sion plant readiness standards is maintained and that these plants are operated properly and safely. The PEB accomplished this with two types of examinations:

- Initial Light-Off Examination (LOE) - Conducted prior to lighting the first fire in any boiler during a regular overhaul, major conversion, or fitting-out availability.

- Operational Propulsion Plant Examination (OPPE) - Conducted no more than six months after the initial LOE and approximately every year thereafter.

Red "E" Project - A CNO Program to improve the material condition of the Fleet. Subsequently renamed the Ship Support Improvement Project (SSIP).

Reliability - The probability that material will perform its intended functions for a specific period under stated conditions.

Reliability Centered Maintenance - RCM is a methodology to develop scheduled maintenance requirements by utilizing a systematic, logical approval of evaluating the failure modes of equipment and their consequences. The resultant scheduled maintenance are tasks that prevent specific failures or tests which assure confidence that essential off-line or non-observed functions are available.

Repair - 1. The restoration or replacement of parts or components of real property or equipment as necessitated by wear and tear, damage, failure of parts or the like, in order to maintain it in efficient operating condition; 2. The restoration of a real property facility to such condition that it may be effectively utilized for its designated purposes, by overhaul, reprocessing, or replacement of constituent parts or materials that have deteriorated by action of the elements of wear and tear in use and that have not been corrected through maintenance; 3. The cost thereof.

Repair Profile - A set of repair actions that has a high probability of occurring during a regularly scheduled ship overhaul.

Repair Requirements for pre-EOC Overhaul - A document that identifies pre-EOC repair requirements essential to support an Engineered Operating Cycle for ship classes in the program.

Routine Maintenance - Maintenance actions performed on a regular basis by all maintenance levels; includes planned, preventive, and corrective maintenance as well as routinely accomplished shipyard maintenance actions.

Ship Alteration (ShipAlt) - Any change in the hull machinery, equipment, or fittings that involves change in design, materials, number, location, or relationship of the component parts of an assembly.

Ship Alteration and Repair Package (SARP) - A document developed from the CSMP, POT&I, and work requests and published by PERA, or its designated agent, giving a system-by-system breakdown of approved repairs and authorized alterations to be accomplished during overhaul. For all repairs and for alterations, shipyard man-day-cost estimates are provided. Work screened for the Ship's Force is included in the SARP.

Ship System Definition Index (SSDI) - An orderly identification and structuring of the system and subsystems that make up a total ship. The SSDI defines the system as well as their boundaries and interfaces, creating a common language for communicating information about a ship's configuration.

Ship Work Breakdown Structure (SWBS) - Classifies the functional segments of a ship, as represented by a ship's structure, systems, machinery, armament, outfitting, etc., using a three-digit system of numeric groupings.

Ship's Force Overhaul Management System (SFOMS) - Simple management system for all levels of Ship's Force efforts to permit the integration of an overhaul or RAV with the total industrial effort.

Shore Intermediate Maintenance Activities - A shore-based maintenance facility. Existing FMAG facilities will be expanded and modernized or new facilities will be established at Norfolk, Charleston, Mayport, San Diego, and Pearl Harbor.

Shore-Based Repair Activities - Naval Ship Repair activities ashore under the management control of the Chief of Naval Material, of Fleet Commanders in Chief, and commercial ship repair yards under contract to the Navy.

Supply Operations Assistance Program (SOAP) - The required concentrated efforts of assigned shipboard personnel under the supervision of a shore-based SOAP Team. The purpose of a SOAP, usually accomplished during an overhaul, is to refine shipboard inventories of repair parts, update related stock records consistent with prescribed allowances, and identify excesses and deficiencies. A SOAP entails offload of material, identification and inventory, requisitioning deficiencies, and material reload.

System Engineering Analysis (SEA) - An engineering process that evaluates the design and experience of a selected ship system and develops an overall maintenance plan describing those maintenance actions necessary to support an item's material condition.

Technical Repair Standard (TRS) - A standard that specifies the minimum requirements for the acceptable repair and refurbishment of an item.

Technical Support - Engineering or technical assistance provided to achieve a specified goal.

Tenders (AD, AR, AS, etc.) - Classes of ships capable of providing mobile intermediate-level repair facilities to both CONUS-based and deployed ships.

Type Commander (TYCOM) - The Administrative Commander for all ships of a common type (i.e., COMNAVSURFLANT, COMSUBPAC, etc.). He is responsible for the scheduling and implementation of alterations, maintenance, repairs, industrial and tender availabilities, overhauls, and the general logistic support of ships under his command.

Upkeep Period - A period of time assigned a ship, while moored or anchored, for the uninterrupted accomplishment of work by the Ship's Force or other Forces Afloat.

Weapon System File (WSF) - The single mechanized repository of ships equipment configuration information located at SPCC. This file can accommodate the requirements of the configuration accounting system for electronics, ordnance, and HM&E equipments. The data contained in this file are used in the production of the COSAL.

APPENDIX K

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